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UNITED STATES DEPARTMENT OF AGRICULTURE

FOREST SERVICE

ANNUAL INVESTIGATIVE REPORT FOR 1929 AND
PROGRAM FOR 1930

CENTRAL STATES FOREST EXPERIMENT STATION

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ANNUAL INVESTIGATIVE REPORT FOR 1929 AND
PROGRAM FOR 1930
CENTRAL STATES FOREST EXPERIMENT STATION

Staff

Permanent Members

E. F. McCarthy----------------------------Director
J. T. Auten------------------------------Silviculturist
Ralph K. Day-----------------Assistant Silviculturist
Leonard F. Kellogg-----------Assistant Silviculturist
Leonard I. Barrett-----------Assistant Silviculturist
*John H. Hanley-----------------------Junior Forester
**Robert K. Winters-------------------Junior Forester
*Louise L. Davis------------------------Senior Clerk
Ruth G. Ent---------------------------Assistant Clerk
Mary Jane Nimocks----------------------Junior Clerk

Collaborators

Edgar N. Transeau---------------Ohio State University
Homer C. Sampson----------------Ohio State University

Field Assistants

Clyde R. Cochran
Theodore S. Coile
Robert B. Gordon
William F. Klug, Jr.
Ben Lucas
Elwood P. Schmink

* John H. Hanley - resigned Sept. 1, 1929.
Louise L. Davis - resigned Dec. 18, 1929.
**Robert K. Winters - employed during summer only.

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Central States Forest Experiment Station

GENERAL

The Central States Forest Experiment Station was organized at Columbus, Ohio in July, 1927. Since its sphere of work covers all of five states and parts of three others, some time may yet elapse before the station is well known in the region it serves. For this reason the statement is again made that the Station is authorized by its organic law "to conduct silvicultural, forest fire, dendrological and other experiments and investigations, independently or in cooperation with other branches of the Federal Government, and with States, universities, colleges, county and municipal agencies, associations, and individuals, to determine the best methods for the growing, management, and protection of timber crops on forest lands and farm woodlots."

The region served by the Station includes the states of Ohio, Indiana, Illinois, Iowa, Missouri, the western portions of Kentucky and Tennessee, and the northern part of Arkansas. Except for the prairie extending from northwestern Indiana westward on the uplands, and isolated prairie areas in other states, the region was all formerly forested.

From the time of early settlement the forest was ruthlessly cleared away to give place to agricultural crops. The demand for crop land caused the clearing and plowing of much hill land which was not suited for agricultural use. As agricultural development opened cheaper land further west, abandonment of hill land began in the eastern part of this region. The introduction of heavy farm machinery and movement of younger people into industrial centers helped to bring about the present condition.

Another factor in the abandonment of farm land is the lack of timber on the farms themselves for the replacement of buildings and fences. The high cost of lumber and other structural materials prohibits the reconstruction of the farm plant. Freight rates are an important factor in this increased cost of lumber.

While there is a ready recognition of the futility of farming those lands which cannot compete with those of better type and at the same time yield profit enough to keep the farm from deterioration, agricultural agencies have not tried actively to develop other uses for this land. Just at this time there is a growing sentiment toward constructive planning for the use of marginal land and a definite attempt is being made to hasten the readjustment in the use of land which will later be abandoned. This movement is none the less decisive because it originates from the recognition that there is an excess of land producing agricultural crops.

The problem of re-establishment of forest on abandoned farm land is economic rather than silvicultural. In most cases the present owners of the land will not have the capital or the future outlook needed for reclamation of these farm lands through forestation. Ownership in most cases will change, but time will be required to convince the present owner that his estimate of value of his land is too high. When land values have decreased to their intrinsic worth for forest production purposes, public acquisition can go ahead as rapidly as forest tracts can be consolidated.

This program of public acquisition of forest land for the Central States region is rapidly taking shape and experimental work must proceed rapidly to permit sound planning for the management of these lands. Purchases have been made on a price basis determined by guess and custom rather than accurate knowledge of value for forest crops. Studies of yield in forest crops now partly under way will put this valuation on a more certain basis. Studies of plantations and natural regeneration will furnish the basis for sound working plans for forest reestablishment.

The variable factors which must be considered in a forest research program for this region were discussed in detail in the 1928 report. Many species reach their limit of distribution in this region and because of this, changes take place in the composition of the forest. The outstanding climatic factors are the decrease in moisture from southeast to northwest and decrease in mean temperature from south to north. Soils of the region are the product of all the geological ages back to the earliest sedimentary rock formation and include those resulting from five glacial periods. The southern forest comes north in the river bottom lands and the northern forest survives in the bog lands of northern Indiana and Ohio.

The geographical location of the central group of states, the diversity of geological structure and climate combine to increase the complexity of the forest research problems. The same causes make results applicable to a broad range of conditions.

The station is now entering its third year of active work on a definite program after a hurried examination of the region in a study related to flood control. During these two field seasons the work done by a small permanent staff has centered chiefly in the better agricultural sections of these states because farm woodlots and plantations have been associated with intensive agriculture and these two projects have taken a large part of the station time.

Work done in the more intensively developed agricultural sections must be carried on by arrangement with owners of farm woodlands and plantations. This work has been given precedence partly because of the urgent need for better practice in the handling of farm woodland and partly because cutting in woodlands and plantations is destroying the opportunity to get valuable records. The requirement of a reconnaissance type of investigation in the beginning of these projects allowed work to proceed before the selection of centers of work.

ADMINISTRATION

Research Facilities

Due to the excessive demand made upon the Station finances during the year for salaries of permanent and temporary personnel and field travel, very little permanent equipment was added to that acquired by the Station during the first year following its creation. One additional automobile, making a total of three, and a Beck Speed-o-graph are the principal items newly acquired. Some few additions were made in files, library cases, cabinets and field instruments.

The Station's reference library is being increased as funds are available and now contains ninety seven bound volumes and approximately seventeen hundred bulletins, circulars and pamphlets, besides a complete set of the Proceedings of the Society of American Foresters, Journal of Forestry and Botanical Abstracts.

The photograph file contains five hundred and nineteen mounted photographs. Three hundred and seventy three photographs were taken during the year by members of the Station. There are four hundred and eighty seven slides in the lantern slide collection.

In all specific cases where laboratory equipment has been required, the University has been very liberal in supplying our needs. Our requirement in this direction promises to increase as we begin making specific studies involving analyses of leaf litter, humus and soils. As the specific need arises an attempt will be made to secure the cooperation of the University in furnishing space and permanent equipment.

Personnel

A place made vacant by the resignation of Dr. B. S. Meyer in the preceding year was filled by the employment of Dr. J.T. Auten. Dr. Auten joined the staff in July with the grade of a silviculturist and will undertake studies which involve detailed work covering the soils and condition of forest floor. Dr. Auten has had in addition to training in soils research, six years of teaching experience on the faculty of the forest academy at Mont Alto, Pennsylvania.

The Station suffered a very material loss in the resignation of John H. Hanley in September of this year. Hanley joined the staff at the time the Station was organized and did very effective work in the conduct of field studies and supervision of field parties. Hanley has entered the University of Illinois with the purpose of taking advanced work.

The Station lost the services of a very efficient senior clerk, Mrs. Louise L. Davis, who resigned in December to return to Virginia. The place she left vacant was filled by the promotion of Miss Ruth G. Ent to the grade of Assistant Clerk. The place left vacant by this promotion was filled by Miss Mary Jane Nimocks from the register for junior clerk-stenographer.

No attempt has been made to fill the place left vacant by the resignation of Hanley because of the limited allotment given the Station. This position will not be filled until an increase is made in the Station's allotment in order to avoid restricting the amount of field work.

Mr. Robert K. Winters who was on furlough during the school year reported for work at the Station during the summer period, returning in the fall to complete his last year's work for a Doctor's degree at the University of Michigan. We are glad to announce that Harold F. Morey who worked during two summer seasons with this Station, received a permanent appointment as Junior Forester at the Allegheny Station. Ray F. Bower, formerly employed in temporary capacity at this Station has entered the employe of the Forestry Department at the Ohio Agricultural Experiment Station. Mr. Robert B. Gordon employed by the Station in temporary capacity received a rating of assistant ecologist on the civil service register. Theodore S. Coile, for two summers employed as field assistant, entered the University of Michigan Forest School with a junior rating to complete his forestry training.

A policy of selection of temporary assistants from the nearest adjacent forest schools of standing was followed during the summer of 1929. Six temporary employees worked in field projects during the year.

Distribution of Expenditures

The distribution of work done by the Station is indicated by the percentage of the Station allotment spent on each project. Since the fiscal year begins in July the distribution of funds for the fiscal year 1929 (July 1, 1928 - June 30, 1929) is given as a whole rather than attempt a fair apportionment of the last part of that year.

Project	Distribution of Total Expenditure of $30,334.58 for fiscal year 1929 Per Cent	Distribution of Total Expenditure of $18,753.60 (July 1, 1929 to December 30, 1929. Per Cent
Oak yield (Ts-12)	43.16	14.67
Woodland grazing (Pa-1)	21.23	29.34
Plantation (Fp-1)	23.07	46.53
Types (T-1)	3.13	4.75
Flood Control	8.84	
Yellow poplar (Ts-375)	.57	
Management Cutting (Mc-1)		4.33
Erosion		.38

Distribution of field time by States

States	Man Days
Ohio	97
Indiana	294
Illinois	306
Iowa	143
Missouri	95
Kentucky	153
Tennessee	51
Arkansas	80
Total	1219

Working Centers

The Station is committed to the plan of concentrating about specific centers all work which requires repeated measurements on the same area. A brief statement of the development of working centers is presented in this report to further the work of selecting such centers and organization of the work.

While tentative locations of the working centers have already been determined the final selection will follow the development of work which requires definite placement and this in turn will depend upon the expansion of Station finances to allow the beginning of such new work. The arbitrary selection of a working center may readily lead to serious errors so the better plan will doubtless be to allow the ordinary routine of Station work to determine automatically the location of the working center.

This can be illustrated by the conditions arising out of the plantation study. The study of the older plantations was undertaken without a predetermined knowledge of the location of these plantations. Since measurements must be made wherever available plantations are found, the work for two years has been in a reconnaissance stage. As a result of the work already done, a concentration of the plantations has been found in the vicinity of Champaign County, Illinois which may permit the establishment of a center of work in this region for future measurements on these plantations.

Beyond this instance the studies of plantations and woodlot grazing which have occupied a considerable part of the Stations field time have not permitted concentration of work at specific points. In fact for the whole northern end of the Station territory working centers will not be established unless the development of the work indicates lower cost of operation by this means.

During the past year some permanent plot work has been undertaken in southern Indiana on the Clark County State Forest in cooperation with the Indiana State Forester's Office. The Henryville location is a logical site for a center of work in the hill section of southern Indiana so that there is little doubt that the center will be located somewhere in this general region and somewhere within a 30 mile radius of Louisville, Kentucky. During the past year a study of regeneration in chestnut oak has resulted in the establishment of some semi-permanent plots in the hilly section of Ohio, southeast of Columbus. These can be very conveniently examined from central headquarters. A center of work for southeastern Ohio might very well be located at or near the town of Waverly, from which several of the state forests and some private holdings can be conveniently reached.

In the state of Kentucky two areas are being considered by this Station. One in the Knobs region can be conveniently reached from the center of work located in or about Louisville. A second area is suggested in the western edge of the western coal field in the general vicinity of Princeton or Earlington. The former location is made more desirable by the fact that one of the substations of the Kentucky Agricultural Experiment Station is located near Princeton. From this location forests of the western coal field with its outlying formation of Chester sandstone as well as farm woodlands in the limestone sink hole section can be covered.

There is recognized the necessity for establishment of a center of work in Tennessee west of the Tennessee River to deal with problems of reclamation of gullied lands or farm Woodlands of this region. No definite selection has been made. A second problem in Tennessee involves the heavily forested and rugged land in the highland rim region south of Nashville. A location in or near Wayne County is indicated by the general character of land considered for this working center.

In Arkansas the Station is fortunate in having established a national forest upon which research work can be conducted. The Sylamore ranger district of this forest was visited during the past year by one party with the object of instituting studies of a permanent character in case the problem justified it. The problem studied was not sufficiently urgent in nature to require the setting up of permanent areas with the present limited funds available to the Station. At a later time it is hoped that some location on this ranger district will be used by the Station for the study of problems of regeneration in oak and shortleaf pine.

The Ozark forest of Missouri constitutes the largest wooded area of comparatively uniform character within the territory of the Station. No national forest has been purchased in this state although an enabling act was passed at a recent session of the Missouri legislature which permits the acquisition of federally owned land up to 2000 acres in any single county.

Through the cordial cooperation of the State Forester of Missouri a working center came under consideration in Reynolds County during the past year. An examination of this area during the summer showed that in the preceding 12 months severe cutting on this area had rendered it unsuitable for the Station's purposes. The location of work in Missouri is being held in abeyance pending the finding of another area suitable for studies the Station wishes to institute.

The recent acquisition of state forest property in southern Illinois and the cordial cooperation of the State Foresters Office opens the possibility of establishing a center of work in the vicinity of Anna, Illinois which will bring within reach the forested hills of the Ozark region of the state and the flat bottom lands along the Mississippi. This will be an especially fortunate location since it will bring a variety of forest types and conditions within the reach of the Station. In addition to the centers of work thus outlined, an extensive territory in northwestern Illinois, northern Missouri and Iowa will call for the ultimate development of one or more centers of work. Thus far the study of woodland grazing and plantations within this section has not pointed clearly the proper location for such a center of work.

In order to promote a better understanding of the purpose and extent of development of these centers of work it should be clearly understood that there is no intention of establishing a permanent personnel at any of these places. The center of work should be of such a character that field parties can be economically housed and maintained and have suitable roads or other means of travel to and from their work. Working areas should not be so far distant from a central location as to prevent travel to and from a place in a period of an hour or not to exceed an hour and a half. As work is increased at these centers some permanent office equipment, tools, and expendible field materials may be accumulated. Parties may occupy a center of work for periods of from several weeks to several months whenever occasion requires.

Wherever permanent plots are established, as they will be in the vicinity of centers of work, a satisfactory agreement will be necessary between the Station and owners of the property to assure protection of the Station's investment of time and money in these experimental areas. In case the areas are privately owned written agreements will be very desirable in order to prevent losses due to change of ownership. Wherever possible, permanent work will be conducted on federally owned lands or lands owned by states or corporations with long time interest in the property ownership.

An Experimental-Demonstration Forest

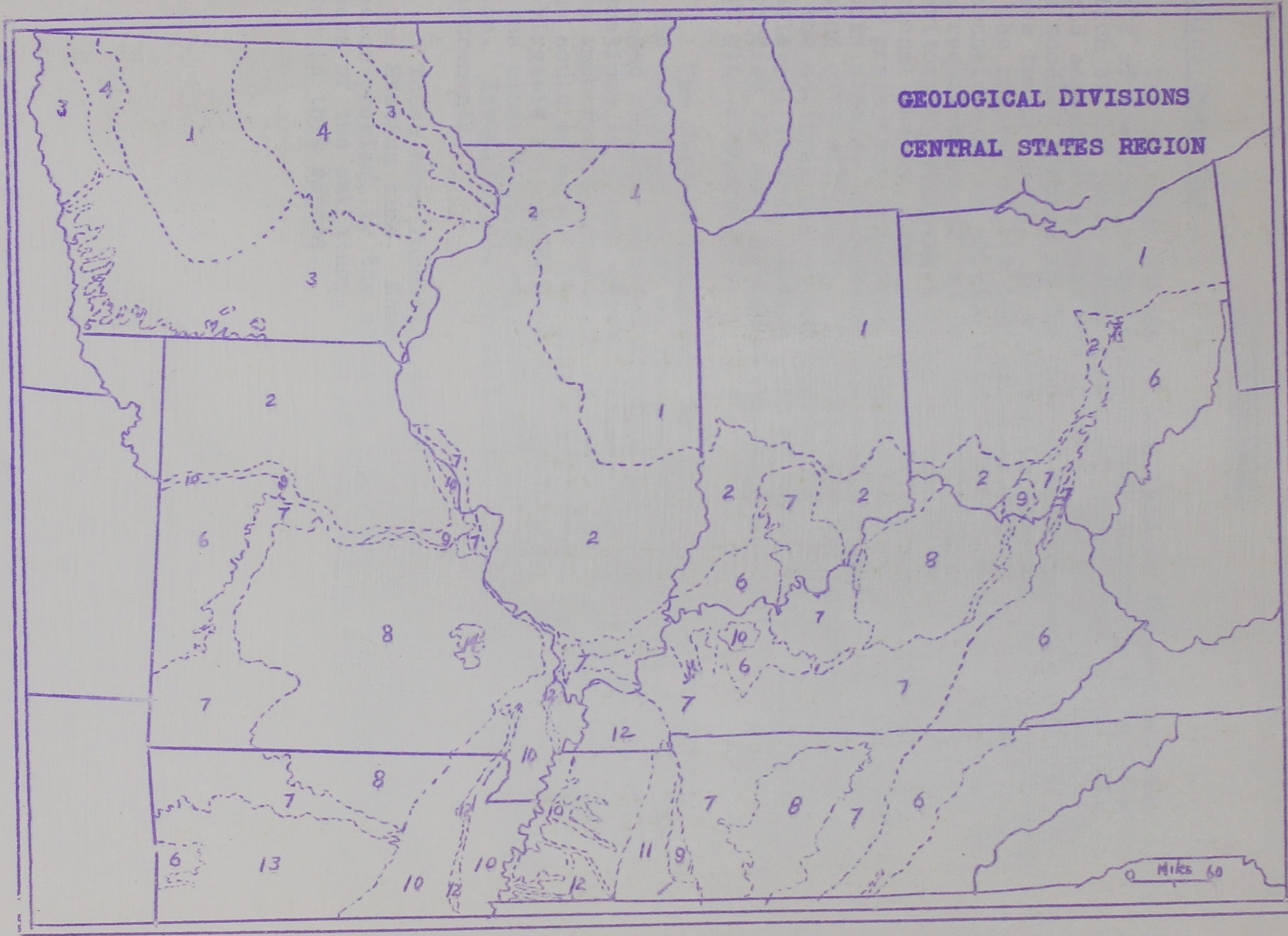
The Station wishes to point out the need for an area of land under its direct control upon which experiments can be conducted and where the results of these experiments may be left for demonstrational purposes. Studies in the regeneration and management of forest land will of course be reported in published form whenever information accrued justifies this action but in addition to this an area is needed where suitable demonstrations can be made of the test of species for planting, the improvement of wild land now forested, the thinning of stands to improve the quality of the final yield and especially areas of forest which can be managed according to the best known practice and upon which records of expenditures can be offset against financial yield. While the primary purpose of the Station in owning or controlling such an area of land by long time agreement is for experimental use, the outcome of such experiments when successful constitute a valuable demonstration. The setting up of a forest area of this type will be dependent upon reasonable increases in the funds allotted the Station and upon the finding and acquiring of rights in a suitable tract. Such a tract of land should preferably be of the type found adjacent to the Ohio River in some of the rough hill lands. While its location may be in any of the states adjacent to the central headquarters, it will be desirable to have such an area conveniently located.

Cooperation

The staff of the Station has continued to assist in forestry instruction at the Ohio State University during the past year. 1929 was the first full year during which the new schedule of two year's work in forestry was in force at the University. This plan provides courses for professional forestry students for the first two years with the expectation that they will go to some other institution for the fulfillment of their degree requirements. The work given at the Ohio State University has been duly recognized by outstanding forestry schools of the country so that students can make this transfer without loss of credit. There is no doubt that this solution of this forestry instruction problem might be well adopted by other agricultural colleges which are limited to one instructor in forestry. Dr. Homer C. Sampson gave several week's time during the summer vacation period of the University to work of the Station.

Forestry officials of the several states have been very cordial in furnishing records and directing searches for satisfactory stands of timber and plantations. State Forester Dunlap of Missouri spent several days in the field with field parties of the Station. Similar assistance was also rendered by State Forester Maddox of Tennessee. Very cordial cooperation was furnished the Station by the Forestry Department of Indiana in assisting in the selection of satisfactory plot areas on the Clark County State Forest and granting the Station the privilege of working on this area.

1. Wisconsin glaciation	Young geologically - glacial till - Lakes and drained lake beds - good agricultural soil, except where sandy.
2. Illinoian glaciation	Light gray soil - low nitrogen - much leached - often impervious subsoil - large amount marginal land.
3. Kansan glaciation	Leached soil - clay subsoil - not best agricultural land.
4. Iowan glaciation	Good agricultural soil.
5. Nebraskan glaciation	Much gumbo till - low fertility - agricultural where not gullied.
6. Pennsylvanian	Hilly to mountainous - largely forested - soils chiefly from sandstones and shales.
7. Mississippian	Reddish soils from limestone chiefly - includes Chester sandstone, soils leached - need lime - Karst formation in part.
8. Ordovician	Blue grass region - agricultural, contains belt of shale.
9. Devonian - Silurian	Limestone and shale - rugged - Knobs of Ky. and Indiana. Topography determines use.
10. Alluvial	Rich river bottom land - overflows.
11. Cretaceous	Fair agricultural soil except where eroded or rugged.
12. Tertiary	Agricultural soil if it can be kept from eroding.
13. Pennsylvanian and Mississippian above Batesville.	Rugged - stony soils - forested - many farms being abandoned.
14. Igneous	Mountainous - forested.



GEOLOGICAL DIVISIONS

CENTRAL STATES REGION

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INVESTIGATIONS

Studies Under Way

The relative amount of work done on the several projects of the Station has already been indicated by the distribution of the funds among these projects. During the 1929 field season preference was given to the study of plantations and woodlot grazing in the hope of securing early reports on these two projects. In addition to this and at the suggestion of the council at its last meeting, some time was spent in a reconnaissance of erosion conditions. Attention was given to the requirements of the one national forest in the Station territory by starting a study of regeneration in the Ozark National Forest. The outcome of this study indicated that, with protection from fire, sprouts will be produced from rootstocks already established and seedling oaks will be established with difficulty. This answers the immediate requirement of the national forest administration. When more funds are available, further studies will be conducted on this forest to determine the best method of bringing about white oak and shortleaf pine regeneration.

The Station recognized the need for early completion of the oak yield study as the preliminary step in the yield of all-aged stands. Several attempts were made to locate cutting operations in second growth timber where measurements of the less important species such as black gum, red maple and pitch pine could be made. The pine measurements were finally taken in Virginia by a member of the Appalachian Station. Few trees of the other species required were cut on any one logging operation. Excessive cost prevented the collection of these measurements.

These more important projects occupied the greatest part of the Station time. Some time was given to the survey of the erosion problem, to the study of types and to reproduction phases of the oak study. All of this work is reported in detail later in this report.

Fp-1 Plantation Study

In the Annual Report for the year of 1928 a cumulative estimate of planted areas in the various states in the territory covered by this Station was set forth. Field work has demonstrated that these estimates are running high for existing areas planted to forest trees. There are many reasons for this. Among them may be mentioned cutting, which has removed parts or all of the many plantations which were made in former times. Pasturing is another factor which has resulted in the disappearance of some of these plantations. The presence of stock very frequently results in the deterioration and actual death and disappearance of trees, especially on areas where the growth is none too vigorous when stock are admitted before the trees are above their reach and the species is not well suited to the site. Drowning of trees in years of excessive precipitation and likewise drying out of the soil in years of drouth have further diminished the original total area of all plantings. Insects such as the borer damaging black locust have also taken their toll. These, among other agencies, have materially reduced the gross area of planted lands.

An added circumstance which has made very material reduction in the total area of plantations available for this study has been the character of some plantings, Large amounts of these early plantations were in the form of narrow hedgerows and windbreak belts 1 to 2 rows of trees wide. The acreage covered by this type of planting has been very large in the past and these are useless for purposes of this project.

Immediate objectives of the plantation project as outlined in the report of 1928 remain intact. In view of field work which has been done over two seasons and the segregation of plantations as found, an added objective for this project is a report dealing particularly with the treatment of black walnut in planted form. There are several reasons why this seems feasible. In the first place there already exists an adequate basis in older plantations for a study dealing with this species alone. Almost half of the plantations which have been visited are black walnut. This situation in itself would justify a separate treatment of this species. In the second place, there is very widespread interest in this species which is perhaps greater than for almost any other of the trees which are commonly planted. In the third place, the older plantations on the best soils already have developed to the place where they are producing material of commercial size. Cutting is taking place in these plantations about as fast as the trees become merchantable. If the development which these plantings have made is to be measured and if advantage is to be taken of cuttings to secure data on felled material, such measurements must be taken in the immediate future to avoid the passing of these opportunities.

The personnel engaged in this project during the past season included six men, under the direction of L.F. Kellogg. During the field season he was assisted by John H. Hanley and R.K. Winters with the help of three temporary employees, T.S. Coile, C.R. Cochran and Ben Lucas. Hanley and Lucas were engaged in this project for a relatively short period in the summer. Winters and Coile worked the full summer season and Cochran's time extended on through the autumn to the close of field work.

The field season began on May 15 when Hanley and Kellogg went to southern Indiana where some of the plots established last year were revisited and photographed and a start was made at establishing plots in the plantations in the Clark County State Forest near Henryville, Indiana. As soon as the temporary assistants arrived in June, the crews entered the field and continued until the beginning of school or until shifting of crews caused them to discontinue their work. Cochran continued to work with Kellogg in Kentucky and Illinois until November 20.

Following is a table showing the amount of time spent on this project by months:

Time Spent on Field Work
For The Plantation Project
-Season of 1929-

Month	Man - Months						
	Kellogg	Hanley	Winters	Coile	Cochran	Lucas	Total
May	0.50	0.50	-	-	-	-	1.00
June	0.66	0.40	0.66	0.66	0.66	0.40	3.44
July	0.66	1.00	1.00	1.00	1.00	1.00	5.66
Aug.	0.90	0.26	1.00	1.00	1.00	0.26	4.42
Sept.	1.00	-	0.66	0.66	0.66	-	2.99
Oct.	1.00	-	-	-	1.00	-	2.00
Nov.	0.66	-	-	-	0.66	-	1.32
Total	5.38	2.16	3.32	3.32	4.99	1.66	20.83

The demands of this project require a high degree of mobility. Older plantations are scattered over an expanse of country covering more than four states and in order to visit, inspect and perhaps measure them, considerable automobile travel is necessary. Because of the taking of volume table data on standing trees during this field season, it was necessary to sample plantations in all portions of this Station's territory where walnut plantations were known to exist. This resulted in considerable more mileage than would have occurred had work been confined merely to the taking of yield plots and measurement of planted stands. Three cars were used during the field season by means of which a total of 22,140 miles was travelled. Most of this occurred during the months of June to August. In the course of this travel, added advantage was gained by locating all available walnut stands in Iowa so that knowledge is at hand as to which stands are suitable for plot purposes. The supervision of the field crews and routine work and the taking of photographs on last year's plots also necessitated considerable travel.

Field work was organized to include three activities. (1) inspection and measurement of plantations, (2) the securing of stem measurements on black walnut for the construction of black walnut volume tables, as the initial step preceding the study of yield for this species, (3) the supervision by the project leader over the two crews, reconnaissance of country containing unlisted plantations suitable for uses on this project and preparation of maps of last year's plots. An added feature of considerable importance was the taking of photographs for purposes of record and illustration in publications.

The purpose of taking the plots is to secure actual measurement on sample areas of planted stands. A two man crew is adequate for this work. At least one party was engaged in this activity almost continuously through the season. It was initiated by Hanley and Kellogg in May in Southern Indiana, continued through the summer by Hanley and Lucas, and resumed by Winter's crew at the termination of the major work of that party. Cochran and Kellogg carried on the work to the close of the autumn.

The methods of plot establishment and measurement which were followed are those outlined in the working plan under which this project has been carried on.

Statement of Plot Work Accomplished-Season of 1929

Species	Plots	Spread of Age	Spread of Dom. Hts.	State
	-No.-	-Years-	-Feet-	
Ash,Green	2	44-48	50-55	Illinois
Ash,White	3	25	30-50	Indiana
Catalpa,Hardy	1	41	75	"
Cedar,E.Red	1	44	36	Illinois
Conifers,Mixed	1	36	45-49	"
Cottonwood	1	57	87	"
Hdwds.,Mixed	13	25-57	39-93	(4 Indiana (9 Illinois
Locust,Black	2	11-27	39-72	Indiana
Maple,Silver	8	46-65	69-83	Illinois
Oaks,Mixed	2	25-58	45-55	(1 Indiana (1 Illinois
Pine,Virginia	2	19	35-40	Kentucky
Poplar,Yellow	7	23-26	37-63	"
Spruce,Norway	2	53-57	53-54	Illinois
Walnut,Black	72	18-70	41-81	(8 Kentucky (60 Illinois (4 Indiana
Total	117	-	-	

As in 1928, a majority of the plots which were taken are of black walnut. Individual plots of several other species have been secured as the stands were met in the field. This season's field work took the crews into the edge of the country in which silver maple has been very commonly planted so that 8 plots were secured for this species. Stands of planted yellow poplar in Kentucky yielded 7 plots in this very valuable species. A total of 117 plots of all species were taken throughout the season. A few of these were in Indiana, more were in Kentucky and a majority of them were in Illinois. Following is a distribution of plots taken in 1928 and 1929 by the states in which they occur.

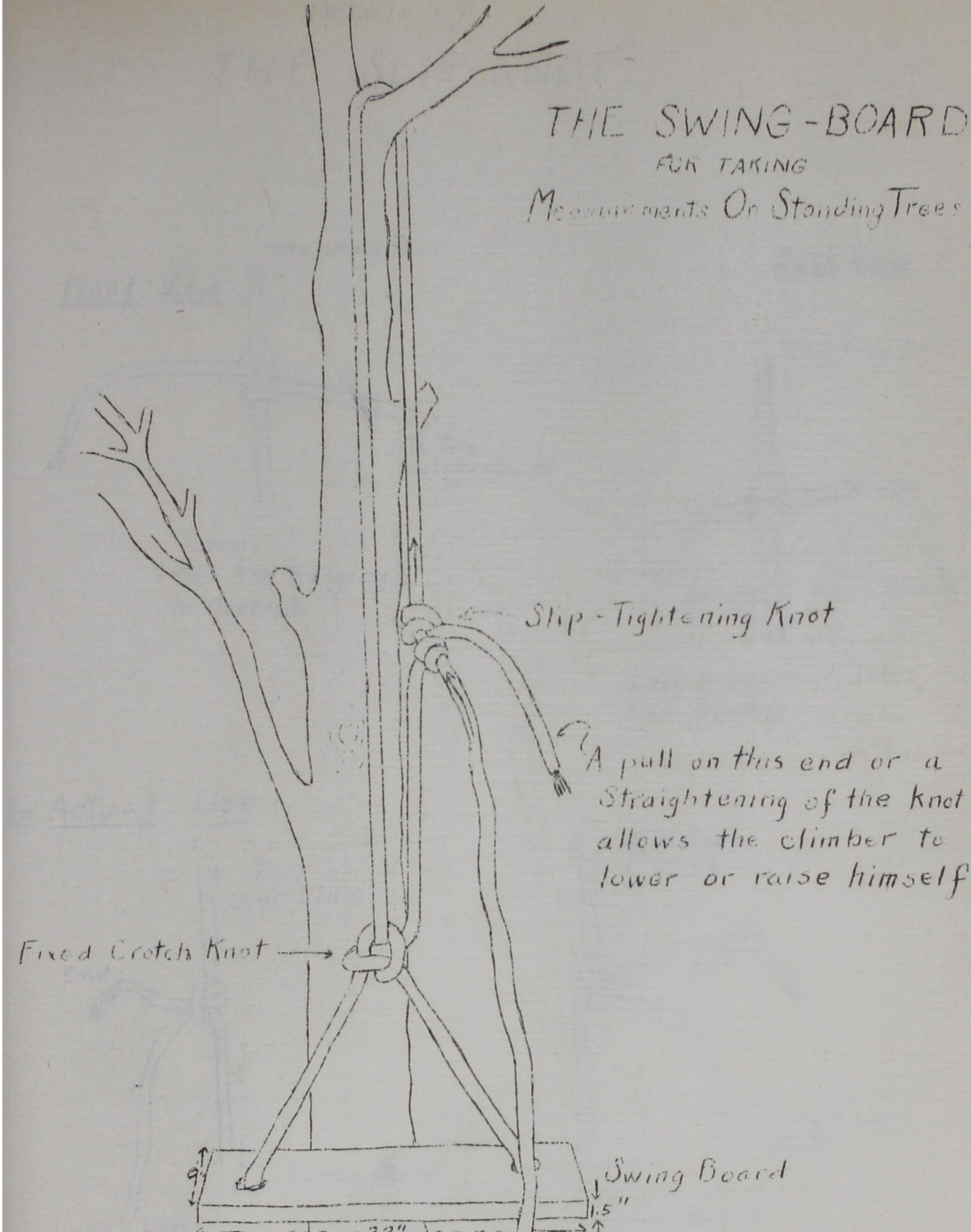
Summary of Plots by States
-Season of 1928-29-

State	1928 Plots -No.-	1929 Plots -No.-	Total -No.-
Illinois	10	85	95
Indiana	39	15	54
Kentucky	-	17	17
Total	49	117	166

The second division of the season's field work consisted of securing data for black walnut volume tables. In order to carry on a study of yield, it is necessary to construct volume tables showing the contents of trees of various heights and diameters in terms of board feet and cubic feet. R. K. Winters was chief of the party which secured the measurements for such tables. He was assisted by T. S. Coile and C. R. Cochran. The latter had a special training and experience in climbing trees. Special equipment for this work consisted of a 14-foot extension ladder, 150 feet of 1/2 inch hemp rope, a swing board seat, an 8 foot bamboo pole marked in 1 foot lengths and a telephone climber's safety belt and strap. As worked out, Cochran used the ladder to a height of 24 feet, after which he shinnied on up to the highest dependable crotch, carrying one end of the 1/2 inch rope and one end of a 100 foot steel tape with him. The rope was fed through the crotch hand over hand until the men on the ground could reach the end and by continued pulling, draw the swing board up to Cochran's location in the tree. After he had secured the tree's total height by means of the tape and pole, and all measurements above the crotch, Cochran was then able to lower himself by means of a special slip knot to definite points at which diameters and bark thicknesses were taken. Distances were taped directly along the stem of the tree.

Diagrams are enclosed showing the character of swing board arrangement (Fig.1) and knots used (Fig.2) in order to make available these hitches which allow the taking of measurements on standing trees with maximum assurance of safety.

THE SWING-BOARD
FOR TAKING
Measurements On Standing Trees


Slip-Tightening Knot
Fixed Crotch Knot
9"
Swing Board
1.5"
22"
Long Loose End.

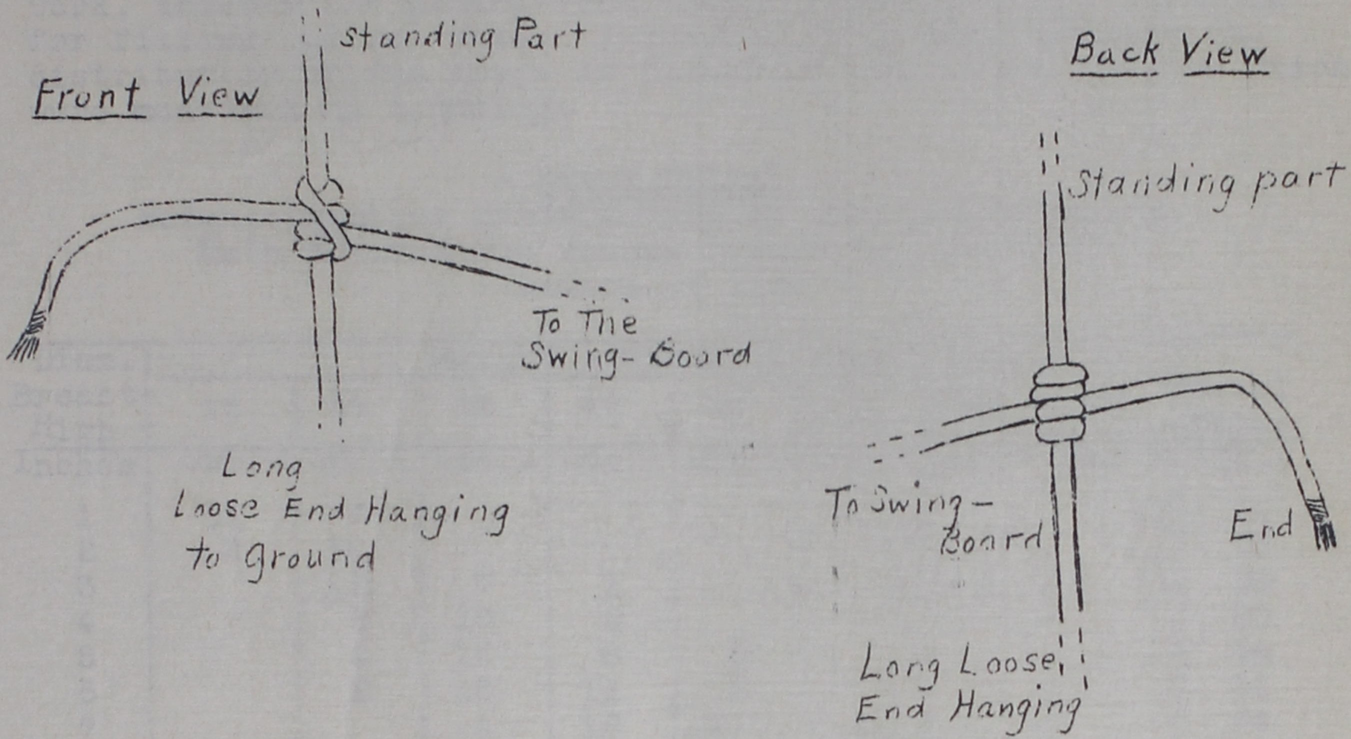
A pull on this end or a Straightening of the knot allows the climber to lower or raise himself.

-Fig. 1-

L.F.K.

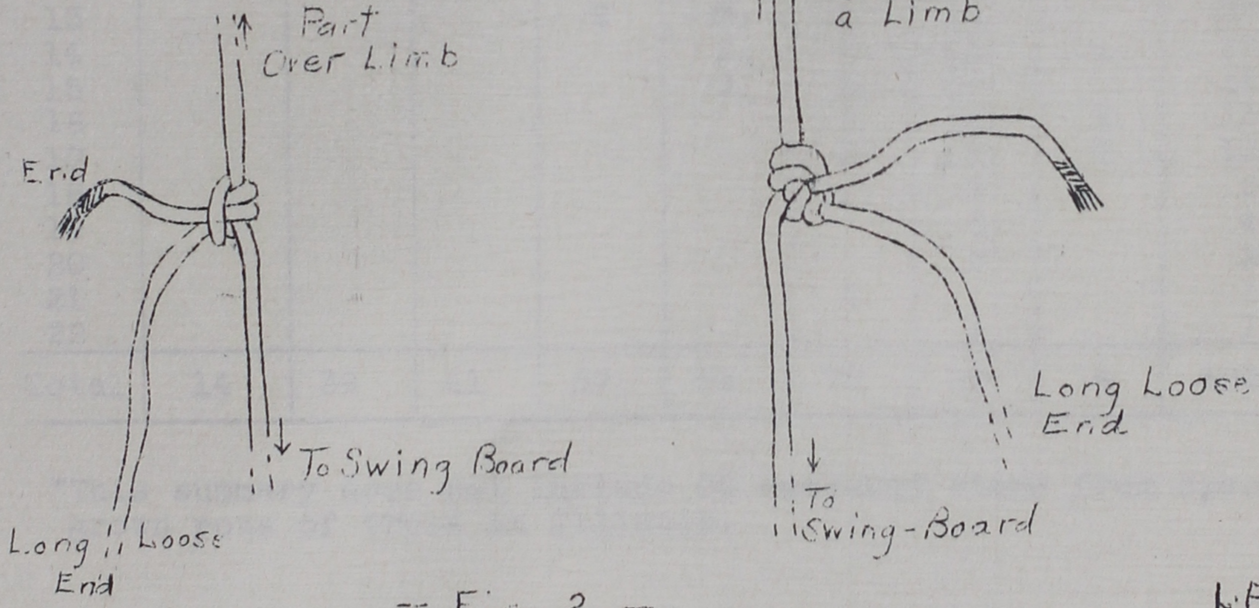
Details Of

THE SLIP-KNOT


Front View

Back View
standing Part
To The Swing-Board
Long Loose End Hanging to Ground
Standing part
To Swing-Board
End
Long Loose End Hanging

In Actual Use:


Part Over Limb
End
To Swing Board
Long Loose End
Part Over a Limb
Long Loose End
To Swing-Board

-- Fig. 2 --

L.F.K.

While measurements were being taken from the top of the tree downward, the second man on the ground beneath recorded these measurements as they were called out by the climber and in addition took measurements of diameter and bark thickness on the basal portion of the tree up to 9 feet. The chief of party meanwhile selected the trees to be climbed, supervised the work of the other two men and in the latter weeks of the work, scouted for plantations which contained trees suitable for filling out the data. Following is a table showing the distribution of the trees by diameters and height classes which were measured by climbing:

- Black Walnut -
Height-Diameter Distribution of Stem Measurements
Data Secured for Volume Tables by Climbing*
- Season of 1929 -

Diam. Breast High	Height - Class In Feet								
	15	25	35	45	55	65	75	85	Total Trees
Inches	-No.-	-No.-	-No.-	-No.-	-No.-	-No.-	-No.-	-No.-	-No.-
1	11	3							14
2	3	10							13
3		12	7	1					20
4		8	10	2					20
5		4	10	8	2				24
6		2	10	11	8				31
7			4	10	17	3			34
8				8	19	9			36
9				8	10	8			26
10				5	8	12	3		28
11				2	9	12	6		29
12					10	10	8		28
13				2	3	11	11		27
14					1	4	11	1	17
15					2	4	10		16
16						1	10	2	13
17						2	7	1	10
18						1	5		6
19							4		4
20							2		2
21						1			1
22							1		1
Total	14	39	41	57	89	78	78	4	400

*This summary does not include 50 measured stems from open-grown rows of trees in Illinois.

In addition to these 400 measurements, 50 stems were measured by Hanley's party in Illinois on areas where walnut was being cut from open-planted rows. This makes a total of 450 stems measured, of which 135 were taken in Illinois, 183 in Indiana, 102 in Iowa and 30 were taken in Kentucky to test the form which planted walnut has in that state.

The third division of the season's work was carried on by the project leader and consisted of supervision of the two parties, reconnaissance to locate additional plantations, and the taking of photographs. Supervision was simplified by keeping the two parties working fairly close to each other. During a considerable portion of the season both parties were in the walnut belt of central eastern Illinois. Early in the season maps were prepared of some of the plots taken during 1928. Additional plots were established at Henryville, Indiana on the state forest prior to the time when temporary field assistants were available. Similarly, in the autumn after the departure of temporary assistants plot work was carried on by Kellogg and Cochran in Kentucky and in Vermilion County, Illinois.

In the taking of photographs, a special effort was made to cover all plantations which had been taken the previous season which were capable of showing particularly significant features and reactions of the planted trees to the sites on which they were located. In like manner, the current year's plots were closely inspected for opportunities to secure photographs.

Summary of Photographs Taken
By the Personnel on the Plantation Project
- Field Season of 1929 -

Subject	No. of Views
Plantations	
Black Walnut	81
Yellow Poplar	17
Black Locust	8
Conifers	8
Chestnut	7
Silver Maple	5
Ash	5
Sycamore	3
Catalpa	3
Red Cedar	2
Butternut	2
Oaks	1
Black Cherry	1
Osage Orange	1
Honey Locust	1
Mixed	1
Seedlings to show initial root & leaf habit	27
Yellow Poplar (natural)	19
Old Uses of Wood	11
Erosion	6
Grazing	4
Other	1
Total	214

Wherever opportunity came to secure pictures of erosion, old uses of wood, and grazing, such opportunities were used. In Kentucky several stands of second-growth yellow poplar gave chance for pictures to be used on the yellow poplar project.

In the course of field work, Coile had an opportunity to secure measurements on the relative thickness and number of rings of sapwood in black walnut on an operation where cutting was being done. This, he summarized in a short report entitled "Number of Rings in Black Walnut Sapwood." Later in the fall Cochran and Kellogg were able to secure 71 additional measurements for such a study of sapwood and heartwood in black walnut.

- Black Walnut -
Height-Diameter Distribution of Sapwood-Heartwood Measurements
- Season of 1929 -

	Height Class - Feet				
	50	60	70	80	
D.B.H.	49.6-59.5	59.6-69.5	69.6-79.5	79.5-89.5	Total
Inches	-No.-	-No.-	-No.-	-No.-	-No.-
7					-
8	1				1
9					-
10			1		1
11				1	1
12		2	6	3	11
13			8	2	10
14	1	4	9		14
15	4	8	9	3	24
16		8	3	5	16
17		1	8	1	10
18	2	3	1		6
19		4	2	1	7
20				1	1
21		1			1
Total	8	31	47	17	103

A total of 103 measurements are available for analysis on the sap-heart ratio of this species. As indicated by the distribution of measurements, cutting **extends** down to and includes trees of 12 inches diameter breast high. Three measurements were secured below this diameter from trees which were accidentally felled in the process of cutting larger trees along side. For this reason the data are incomplete for the diameter classes below 12 inches.

The use of a party equipped to do climbing gave opportunity to try out an instrument known as the Liljenstrom dendrometer and test its use in measuring diameters on standing plantation-grown trees. Such an instrument removes the need of climbing a large number of trees for measurements, providing the readings possess a high degree of accuracy. This instrument comes from Sweden and is considered fairly accurate in that country. Measurements taken with it on large timber such as occurs on the Pacific Coast have been highly accurate. The work of this season allowed a close check on the accuracy of the instrument on small trees because of the presence and use of climbing equipment which allowed a check of instrumental readings against actual measurements. The results of these tests have been summarized by R. K. Winters and have been submitted for a short article in current journals. Briefly it was found that the dendrometer is unsuitable for measuring diameters in planted stands for the following reasons: (1) the almost continual sway of tall planted trees having small diameters renders it very difficult to secure reliable readings; (2) the personal equation becomes very large in the use of the horizontal scale in the eye-piece because of differences in eye sight, shadows behind the tree, and shadows in the bark; (3) relative dense shade in the crown often makes sharp focus and consequent accuracy of measurement impossible; (4) small errors in reading the eye scale become very large because of the relatively small diameters being measured. Errors from 0 to 50 per cent occur in the smaller diameters as read with the instrument. On large diameters such errors become very small or trifling. (5) Because of the lack of an excurrent central stem in walnut, readings are displaced as much as 2 feet above or below the true height of the measured point through curves, sweep, and irregularities in the straightness of the stem.

In view of the need for accuracy in forest measurements, it was felt that this dendrometer is unsuitable for the measurements of diameters and heights on stems of small planted trees.

Opportunity was found to secure measurements on 1 to 3 year old sprouts of black walnut. The stand in which these measurements were taken was partially cut in 1926. Sprouting appears to be quite erratic as shown by many stumps which had none. Although three years had elapsed, several stumps showed only a 1 year old growth. It was observed that early frosts appear to be a cause of mortality in walnut sprouts and this may be the cause of some stumps having only a one year old growth. Additional data are needed on sprout reproduction of walnut. Difficulties will be met in securing more figures in view of the almost universal practice of running stock in walnut groves.

The later development of European larch is not proving entirely successful. This species is easy to establish and initial growth is rapid and encouraging, which has caused the species to be very commonly recommended for planting in the prairie region. At least two of these stands which formerly were very thrifty are now deteriorating very rapidly. Photographs were secured showing this condition and a plot was taken in one stand in Ford County, Illinois which also contains white pine. Following is a summary by diameter and crown class of the two species occurring on this plot:

Illinois
Hanley Plot #24

C. N. Gilmore Farm 2 miles N.W. of Gibson City, Ford Co., Ill.
Age - 36 (1929) Three rows European larch; 5 rows White pine.
Orig. Spacing: Rows 4-5' apart, irregular in rows.
Present Spacing: Eur.larch 3'x 4'; White pine 4'x 10'.

Diameter Tally of the Plot

	White Pine					European Larch				
D.B.H	Dom.	Cod.	Int.	Overtop	Dead	Dom.	Cod.	Int.	Overtop	Dead
1										N.B.
2										
3										
4					1					
5			1		1					4
6		1	5		2			1		5
7		3	2		3		5	1		11
8		8	2		2		2			3
9	1	12				1	1			5
10	3	4				1				4
11	-					1				1
12	1					1				1
13						1				
Total	5	28	10	-	9	5	8	2	-	34

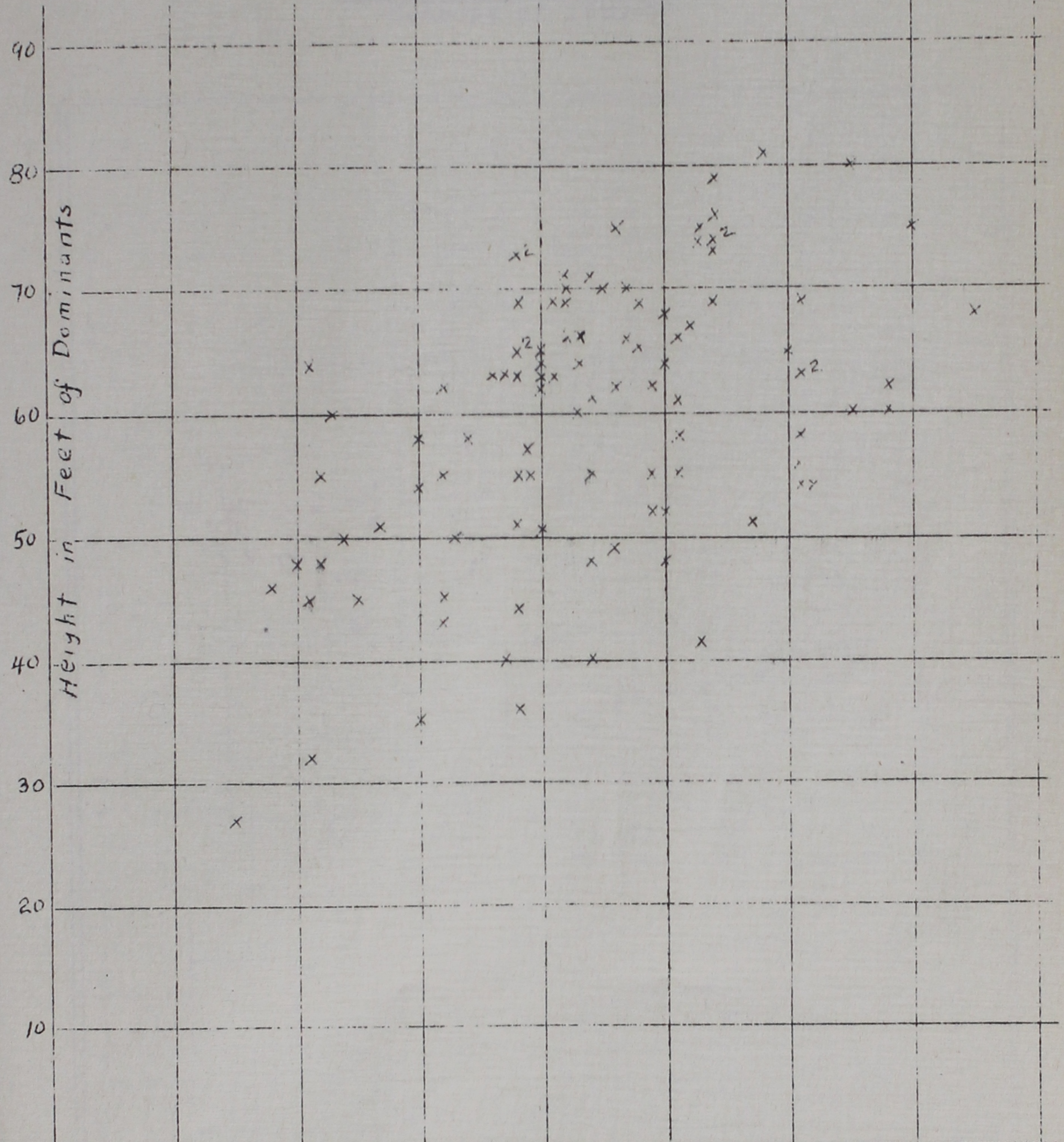
Special attention is called to the last column under European larch which shows twice as many trees of European larch which are dead as are alive. On an acre basis the white pine shows 107.77 sq.ft. basal area of which 12.3 sq.ft. (or 11.4 per cent) is dead wood. In the European larch there is 102.68 sq.ft. of basal area per acre of which 66.11 sq. ft. (or 64.4 per cent) is dead wood. This unfortunate turn in events emphasizes the fact that, while initial growth of planted exotic species may be very promising, the later development may be poor or unsatisfactory. These data further support the contention that it is safest to use native local species in forest plantations.

After two field seasons of work a total of 166 yield plots have been taken in planted stands. Of these, 143 are in pure stands and 23 are in mixtures of ash, conifers, oaks and hardwoods. Of the pure stands, 96 plots are black walnut. Besides these plots, notes have been taken on more than 21 additional plantings which were unsuitable for yield purposes for some reason or other. Following is a graph on which the dominant heights of black walnut trees have been plotted over corresponding ages. The dispersion shows the need of additional plots in plantings in the lower ages, in stands 60 years and older, and especially in the older poorer sites.

BLACK WALNUT

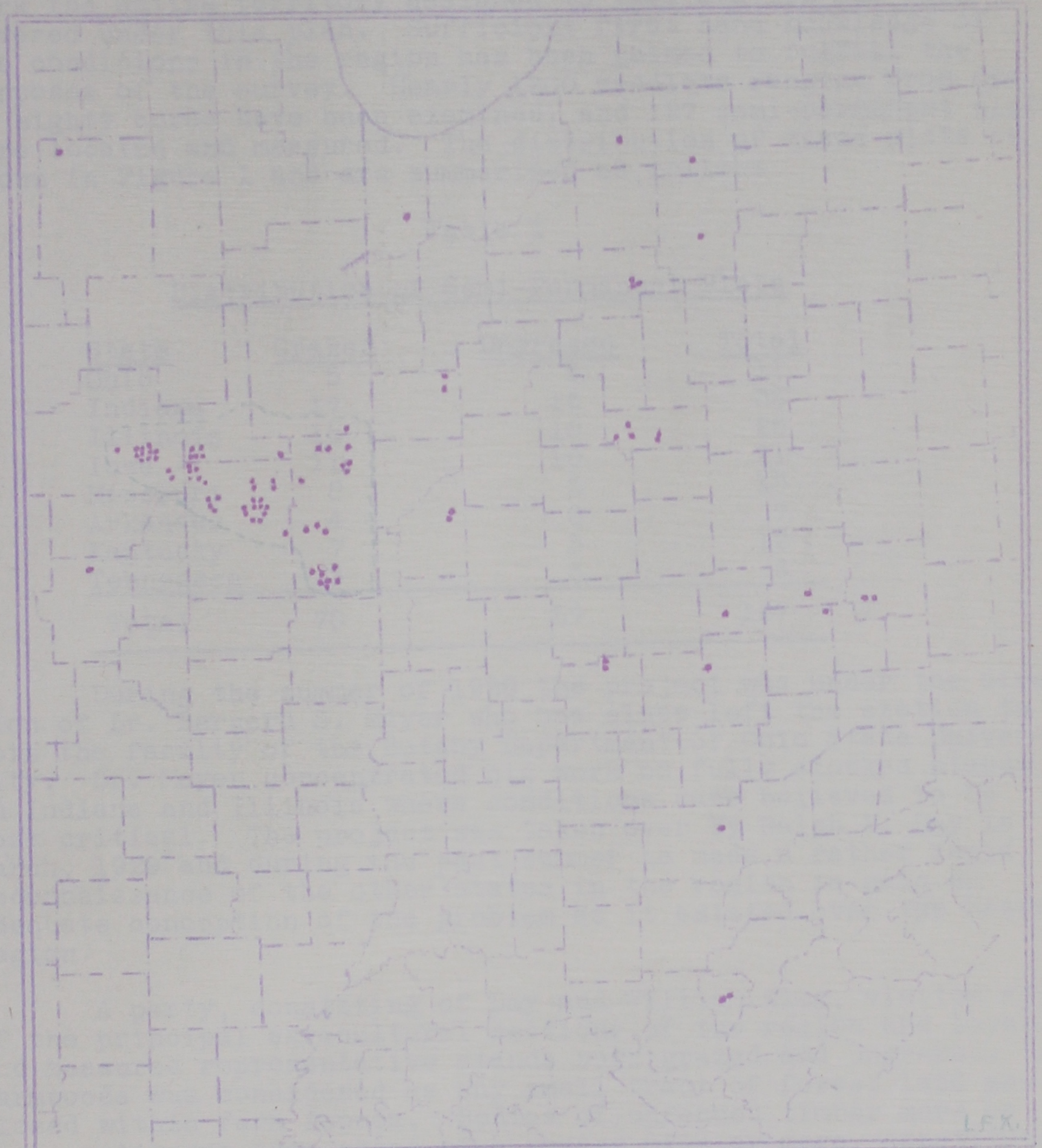
Height-Age Distribution of Plots

Seasons of 1928-29



The additional data which it is desirable to secure on black walnut must come from a continued intensive inspection of walnut stands in Illinois and Iowa. There are occasional plantings in adjacent regions but the majority of the planting of this species has been in these states.

Location of Black Walnut Plots
In Indiana and Illinois
-Seasons of 1928-29



( ) = Limits of 1929 Field Inspection in Illinois.

Pa-1 Relation of grazing to the farmwoods

General

A plan of reconnaissance was set up in the spring of 1928 to furnish a preliminary survey of conditions in the farmwoods as related to the practice of grazing. This phase of the regional study of grazing in the farmwoods was brought to a close at the end of the field season of 1929. In the two years work the entire territory assigned to this Station has been covered under this plan. Sufficient first hand knowledge of the conditions in the region has been gained to fulfill the purposes of the survey. Nearly 1200 woodlots ranging from one to eighty acres have been examined, and 127 semi-permanent plots were located and measured. The distribution of these plots is shown in Figure 1 and are summarized as follows

Table 1

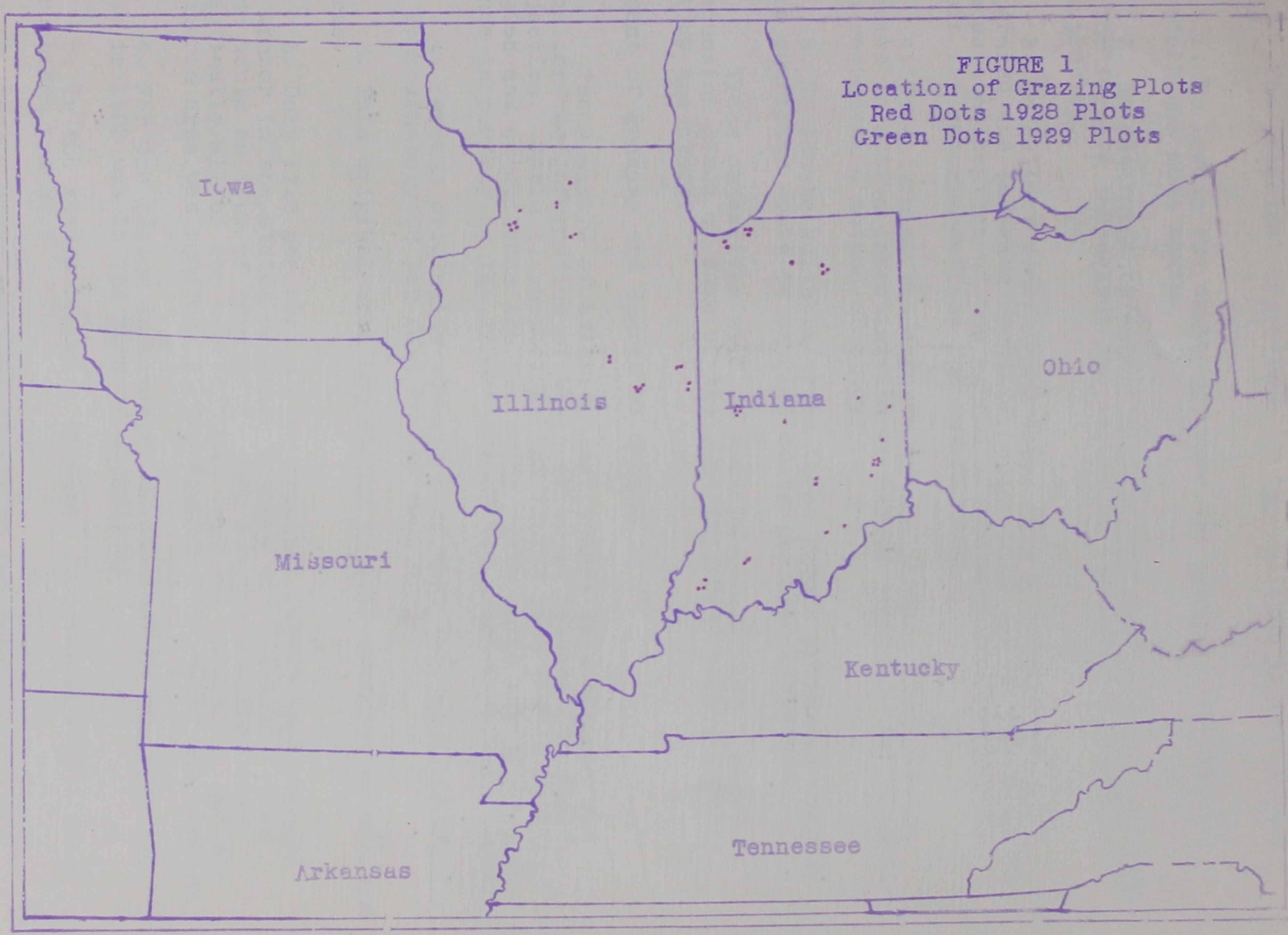
Distribution of Semi-Permanent Plots

State	Grazed	Ungrazed	Total
Ohio	5	6	11
Indiana	17	16	33
Illinois	15	10	25
Iowa	11	10	21
Missouri	8	5	13
Arkansas	4	3	7
Kentucky	7	5	12
Tennessee	3	3	6
Total	70	57	127

During the summer of 1928 the project was under the direction of Dr. Bernard S. Meyer who has since left the station to join the faculty of the Botany Department of Ohio State University. Dr. Meyer concentrated his work on fully stocked stands in Indiana and Illinois where conditions were believed to be most critical. The project was taken over by Ralph K. Day in March, 1929 and during the past summer he made a rather rapid reconnaissance of the other states in the region to gain an adequate conception of the problem as it existed over the entire region.

A party, consisting of Day and William Klug, visited all of the principal agricultural sections of the region and located and measured representative stands both grazed and ungrazed. A farmwoods was considered as any small tract of forest land enclosed within farm fences. Bodies of unfenced timber more or less continuous over areas of a square mile or more, constitute open range grazing conditions and were not considered a part of this particular study.

FIGURE 1
Location of Grazing Plots
Red Dots 1928 Plots
Green Dots 1929 Plots



Iowa
Illinois
Indiana
Ohio
Missouri
Kentucky
Tennessee
Arkansas

The principal objectives of this reconnaissance survey were:

1. To locate the sections where the damage to farmwoods by stock was most acute.

2. To determine by direct contact the sentiment and opinion of the farmers throughout the region on the various phases of the problem.

3. To collect preliminary data, from a comparative study of grazed and ungrazed woodlots, which will aid in obtaining an adequate conception of the extent of the problem and form the basis for recommendations for future work.

4. To determine the aspects of the problem which should receive intensive investigation as future phases of the project and recommend a method of study.

5. To locate suitable areas where future intensive work of this character could be carried on to the best advantage.

These objectives will be briefly covered and a short discussion given of some of the more important points brought out by the study.

Extent of grazing and degree of damage

The analysis of existing statistical data brought out considerable information of basic value in solving the first objective. Table II summarizes the forest land status of this region and establishes the following facts which are of significance in portraying the importance of the problem in this region:

1. Forests originally covered more than 145 million acres or approximately 68 per cent of the region.

2. This original area had shrunk by 1920 to about 50 million acres.

3. Only 17.3 per cent of the original forest area remains in timber in the states of Ohio, Indiana and Illinois. (The same would be true of Iowa if it were not for the fact that practically all of the agricultural land was on prairie and the timbered area was confined to the rougher land along the streams.)

4. For the region as a whole, 63 per cent of the timbered area in 1920 was in the form of farmwoods.

5. In the states of Ohio, Indiana, Illinois and Iowa this percentage was 90.6

6. Nearly sixty per cent of all of the farmwoods in the region are grazed.

Table II

Area of Forest Land in Territory of Central States Forest Experiment Station
(From U.S.D.A. Statistical Bulletin 21, U.S. Census
of Agriculture 1925, and other sources)

State	Total Land Area Acres	Original Forest Area Acres	Forest Area in 1920 Acres	Woodland on Farms 1920 Acres	Woodland on Farms 1925		
					Total Acres	Grazed Acres	Ungrazed Acres
Ohio	26,073,600	25,600,000	4,000,000	3,198,929	2,827,493	1,854,403	973,090
Indiana	23,068,800	19,840,000	3,500,000	3,141,042	2,716,962	1,878,949	838,013
Illinois	35,867,520	16,000,000	3,148,000	3,102,579	2,635,608	1,896,966	738,642
Iowa	35,575,040	5,120,000	2,314,000	2,295,274	2,212,940	1,970,145	242,795
Missouri	43,985,280	32,000,000	13,820,000	8,553,857	7,405,843	4,780,176	2,625,667
Arkansas (1(4)	15,293,080	14,400,000(2)	9,670,000 (2)	3,966,933	2,892,567	1,106,514	1,786,053
Kentucky (1(3)	17,643,940	16,680,000(2)	6,440,000 (2)	3,056,695	2,455,898	705,654	1,750,244
Tennessee(1(3)	16,389,120	15,710,000(2)	7,360,000 (2)	4,535,528	3,563,308	1,054,459	2,508,849
Total	213,896,380	145,350,000	50,262,000	31,850,837	26,710,619	15,247,266	11,463,353

(1) County lines followed in determining acreage
(2) Estimated, no data by counties available
(3) West of Cumberland Plateaus
(4) North of 35th Parallel

7. In the four corn belt states, Ohio, Indiana, Illinois and Iowa, this percentage rises to 73.1.

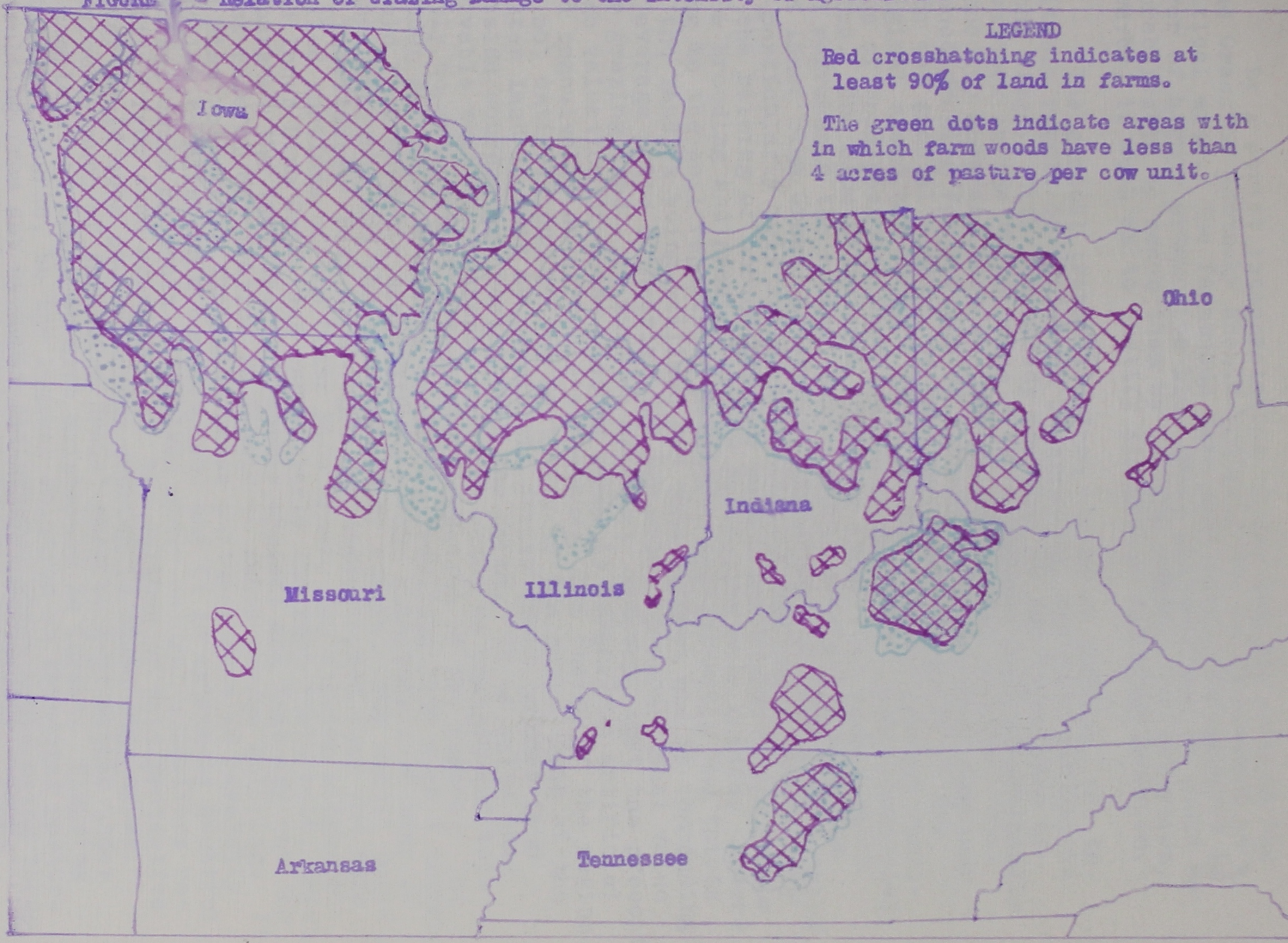
The most significant result of the reconnaissance survey was the close correllation which was found to exist between the rich agricultural sections and the areas where the degree of damage by grazing to the farmwoods is most severe. Figure 2 illustrates this strikingly. It supports graphically the figures in Table II, which indicate that the grazing problem is most serious in the states of Ohio, Indiana, Illinois and Iowa, and shows that within these states it is chiefly limited to the highly fertile glacial soils of the Wisconsin and Illinoian drift areas, the "Corn Belt." This glaciated section which covers 62.4 per cent or nearly two thirds of the Central States region, extends in a broad belt from west central Ohio across the northern two thirds of Indiana, and includes practically all of Illinois and Iowa and the northern third of Missouri.

Within this glaciated section 95 per cent or more of the timber is in isolated patches of from 5 to 30 acres and enclosed within farm fences. Practically all of these farmwoods are grazed more or less continuously, the ungrazed woodlot is the result of accident rather than intention. The high valuation of the land in this section is forcing the farmer to keep every acre possible under cultivation in order to meet his taxes, and the result is that he is unable to maintain sufficient open pasture for his farm stock, and frequently crowds eight to ten head in a woodlot which would probably not adequately support more than one or two animals.

The average woodlot in this section is stocked with the equivalent of one cow for less than every two acres. This is a significant fact in view of the estimates made by several agricultural experiment stations that an average of 3.6 acres are required per cow on the better farm pastures of the middle west. Figures taken from the 127 grazed and ungrazed plots indicate that not less than 10 acres of well stocked farm woodland are required per cow to prevent serious damage to the reproduction by browsing.

Referring again to Figure 2, it will be noticed that south of the "Corn Belt" the regions of intensive agricultural development are limited to much smaller areas, particularly those of Ordovician and Mississippian limestone. In only two of these areas does grazing in the farmwoods approach the intensity found in the Corn Belt. These are the Blue Grass of Kentucky and the Inner or Nashville Basin of Tennessee.

FIGURE 2 - Relation of Grazing Damage to the Intensity of Agriculture.


LEGEND
Red crosshatching indicates at
least 90% of land in farms.
The green dots indicate areas with
in which farm woods have less than
4 acres of pasture per cow unit.
Iowa
Ohio
Indiana
Illinois
Missouri
Arkansas
Tennessee

By a strict interpretation of the grazing problem the "Blue Grass"of Kentucky should probably not be considered as a critical area. The farmwoods have practically disappeared in favor of highly productive blue grass pastures and it would be impracticable to renew them by natural means. The situation, however, is such as to justify discussion and consideration.

The gradual transition from forest to prairie, the inevitable result of continued overgrazing, has here reached its final stage. With the steady increase in the importance of livestock in the "Blue Grass," the farmwoods were intentionally opened up more and more to provide additional pasture. Continued grazing for periods of seventy years or more, together with the gradual removal of dead and dying remnants of the original stand has brought these areas to their present condition of open pastures with scattered trees of little commercial value. The Blue Grass area contains about 8000 square miles and represents the richest agricultural section of Kentucky. The Inner Blue Grass, an area of approximately 2300 square miles is particularly well suited climatically and physiographically to the raising of horses and the region has become world famous as a breeding and grazing ground for select race horses. According to the soil reports of Kentucky, approximately two thirds of the land is being utilized for this purpose and is commanding an average price of nearly $100 per acre, an exceptional value for grazing land. It must be realized, however, that the present high valuation of these pasture lands is largely an artificial and conceivably an unstable situation. The wealth of the region is not entirely due to the fertility of the soil. Much of the better land is held by people who derive their incomes from outside sources but reside upon the farms. It is quite conceivable that the present condition could be changed sufficiently to undermine the economic foundation of the region. The sudden return to a normal condition resulting from such a change would from economic necessity force the cultivation of many of these pastures and the abandonment of others. The result would be inevitable. Past experience has demonstrated that the thin soiled portions of the Outer Blue Grass, the steeper slopes of the Inner Blue Grass and particularly the Eden Shale belt, which separates the two, are very easily eroded; and that any but the most careful cultivation is liable to cause severe gullying. It is also well known that blue grass pastures must be carefully handled to maintain a complete sod and it is extremely doubtful if they could maintain themselves under natural conditions resulting from such abandonment. The failure of this protective cover would soon cause serious erosion in these same areas. Obviously much of the "Blue Grass" must be kept either under a complete sod cover or else maintained in forest. Planting would, of course, be the logical solution on abandoned pasture resulting from any economic disturbance which would bring these lands from a suburban down to a marginal valuation. There is no question that planting should be encouraged in the "Inner Blue Grass" region from an aesthetic standpoint alone. Forest plantations on these lands would enhance their real estate value considerably.

The Central or Nashville Basin has been frequently termed the "Blue Grass of Tennessee." The geology of the section is similar in many respects to the Kentucky "Blue Grass." The same Ordovician limestone is the dominant formation and the area is only slightly smaller than the "Inner Blue Grass." In contrast, however, its topography is quite rolling, it is well timbered except in the immediate vicinity of Nashville and its soils are very thin and easily eroded. Numerous attempts to clear and cultivate land of even gentle slope have resulted in failure.

The grazing industry has thus become of first importance in the section. For example, in Wilson County just east of Nashville, three acres out of five are in pasture, and the value of livestock is approximately equal to all cultivated crops combined. About 85 per cent of the farm woodlands are being grazed but the intensity of grazing is not as great as in the Corn Belt. There are about three surface acres per cow unit as compared to less than two acres in portions of Indiana and Ohio.

The problem here is not one of the total elimination of the farmwoods but is rather one of the selective influence of grazing in gradually converting the timber types over from a composition of valuable oaks, hickories, ashes and red cedar to such worthless species as winged elm, Mississippi hackberry and hawthorne. The limestone is frequently exposed and the soil too shallow on most of these areas to produce good blue grass pastures and it is very probable that an economic study will show that a short rotation of red cedar will give a better return than the forage.

Throughout the remainder of the region, individual woodlots frequently are being as seriously damaged as in the preceding sections, but in general, however, the farms have more open pasture land available and fewer stock and consequently the intensity of grazing is considerably lessened. In the "Pennyroyal"section of Kentucky a material increase in the number of stock will precipitate a serious situation. Between the Missouri River and the Ozark plateau and in southern Illinois, Indiana and Ohio, grazing is of considerable importance but the problem in these regions is principally one of keeping the fire out of the woods. At the present time the damage by grazing is secondary to that by fire. Of course the charge can be made that much of the fire is a result of the mistaken idea that the forage is improved by annual burning, but this question is essentially a phase of the fire problem and will not be considered here.

While this project is not concerned with the more or less open range grazing commonly practiced in the Ozark sections of Missouri and Arkansas, it seems desirable to call attention to the fact that the stock are influencing the reproduction in these woods. McCarthy and others have frequently commented on the apparent fact that shortleaf pine is much more abundant and white oak considerably less in evidence on such areas grazed by stock than on those where grazing is not practiced.

In Table III the various physiographic provinces of the region have been tabulated in their order of importance, based on the acuteness of the grazing situation. The best criterion for judging the relative degree of damage in the regions was found to be the number of acres of pastured woods per cow unit. The numbers of the various classes of livestock found in the woods were converted into terms of cattle in building up this table. In the absence of detailed studies and based on general observations of their relative effect in injuring reproduction, the following more or less arbitrary converting factors were used:

1 Horse or mule = 1 cow
3 Hogs or goats = 1 cow
5 Sheep = 1 cow

Table III

Intensity of Grazing on Farmwoods in the Central States

Physiographic Province	No. of acres of woodland pasture per cow unit
Wisconsin Drift Area	1.5
Illinoian Drift Area	1.7
Central Basin of Tennessee	3.0
Blue Grass Region of Kentucky	3.6
Pennyroyal Region of Kentucky	4.0
Unglaciated Plateau of southeastern Ohio	5.8
Highland Rim of Tennessee	6.6
Tertiary Plateau of Western Ky. and Tennessee	7.2
Knobs Region of Kentucky	7.4
Western Coal Fields of Kentucky	8.3
Ozark Plateau of Missouri, Arkansas and southern Illinois	9.2
Mississippi and Ohio River bottomlands	10.2

The viewpoint of the farmer

Foresters have always held that the woodlot had a legitimate place on every farm. A few acres of timberland to which the farmer could turn for fuelwood, fence posts, and rough timbers was considered a desirable feature. In the Corn Belt, however, the progressive farmer is becoming more and more specialized and is devoting an increasing amount of time to his primary crop with the result that he is becoming dependent upon the general market for materials and products which ten years ago he produced on his own farm. Coal and gas are being used instead of fuelwood because it is more convenient and saves days of work in the woods which the farmer feels could be used to better advantage. Detailed studies of the annual fuel expenses of 70 Ohio farmers made by the Ohio Agricultural Experiment Station showed that in 1927 an average of $35.21 was expended by each farmer for coal, $5.78 for kerosene, $1.29 for gasoline and $1.09 for wood. Similarly the cheapness and convenience of steel fence posts are strong arguments against the old wooden post. With the use of modern farm equipment the farmer is getting away from the old idea of permanent fences and now frequently removes the wires and posts and runs his tractors and machinery over several fields at the same time. The steel fence post which can be set and removed with little effort is ideal for this purpose.

In the eyes of the Corn Belt farmer the woodlot is a place to run his necessary farm stock. Because of the high value of his land he is forced to keep every acre possible under cultivation and the woodlot is often the only place available to run the stock. He is not primarily seeking forage, but chiefly shade and opportunity for exercise. Practically every farmer keeps his stock to a great extent on cultivated foods, prepared rations and by-products of his farm, and depends on the woodlot to furnish only a certain amount of green forage as a conditioner.

The situation and the viewpoint are economic, and, regardless of the fact that many of the farmers are fully conscious of the rapid disappearance of the woods, they are not in a position to alter the conditions. The entire problem centers around the fact that it is more profitable to feed grain to beef and dairy animals and sell the products than it is to sell the grain. Woodland pastures which provide shade and some degree of protection from flies, are desirable features in this plan of animal husbandry and are consequently looked upon in that light. Dairy herds, or fattening beef cattle will yield better returns if they have tree shade in the heat of summer and in fly season. The forester has had little influence on this situation and its solution lies along entirely different lines than the orthodox formulae of the past.

The unique circumstances which have given rise to this viewpoint of the Corn Belt farmer, cannot be said to exist over the rest of the region. The situation as it exists in the "Blue Grass" of Kentucky has been discussed, and with that exception it can be said that the average farmer throughout the remainder of the Central States is indifferent to the problem. The wooded portions of their farms are looked upon largely as waste land, a return of a few cents an acre from grazing is held to be better than none at all. The attitude is natural. The woods have been culled over repeatedly and grazing has prevented adequate reproduction until there is an insufficient growing stock on most of the areas. The inability of the few owners who have a growing stock to profitably market their material, is also one of the principal reasons why the farmer does not recognize his woodlot as an integral portion of his farm, and give it the same attention and management as the rest. Over much of the region the question of markets is more of an immediate problem than the securing of a productive stand or growing stock, and obviously the farmer is sceptical of spending time and money on his woodlot if its products cannot be marketed at a reasonable profit. The moderate grazing of woodlands is looked upon with favor by farmers who are esthetically inclined. To them an open parklike stand is more attractive than an ungrazed woodlot filled with a tangle of reproduction.

The small percentage of woodlands which are ungrazed are usually of such size, location or topography as to be useless for grazing purposes or otherwise contain poisonous plants. Very rarely a woods is found ungrazed for sentimental reasons.

Analysis of the plot data

While the primary objective of the reconnaissance study was to evaluate the degree of damage in the various provinces of the Central States, advantage was taken of the opportunity to gather preliminary data on such direct influences as could be measured by empirical studies.

As indicated in Table IV the data collected are most complete for the Oak Hickory type and for this reason the compilation and analysis of this preliminary data has been confined at present to this type.

Table IV

Distribution of Plots by Types and Per Cent of Stocking

Type	Grazed						Ungrazed						
	Per Cent of Stocking in Stands												
	90	70	50	30	10	Total	90	70	50	30	10	Total	Grand Total
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
Oak Hickory	18	10	8	9	6	51	8	9	9	7	3	36	87
Beech Maple	12					12	12					12	24
Upland Swamp			1			1	2		2			4	5
Bottomland Swamp			2			2	1					1	3
Black Maple		2				2		2				2	4
Red Cedar			1		1	2			1	1		2	4
Total	30	12	12	9	7	70	23	11	12	8	3	57	127

The following tables are indicative of the character of data which can be secured and the nature of the questions which can be answered by extensive methods of this nature.

Table V

Effect of Grazing on the Amount of Litter and Humus
Oak-Hickory Type#

Intensity of Grazing	Depth of Litter and Humus in Inches Per Cents of Stocking											
	90%		70%		50%		30%		10%		Average	
	L.*	H.*	L.	H.	L.	H.	L.	H.	L.	H.	L.	H.
	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
Ungrazed	2.1	.8	1.8	.8	1.5	.5	1.5	.2	1.4	.0	1.8	.5
Lightly grazed	1.6	.6	1.7	.5	.8	.1	.5	.2	sod	sod	1.0	.3
Mod. grazed	1.2	.5	.8	.3	.9	.2	.4	.0	sod	sod	.7	.2
Heavily "	.8	.3	.7	.2	.3	.0	sod	sod	sod	sod	.4	.1

#Basis - 87 plots
*Litter
*Humus

Table VI

Relative Frequency of Browsing of Tree Species by Cattle and Horses

Oak-Hickory Type

Central States Region

(Based on the percentage of the reproduction over 6 inches high which had been browsed.

Relished under all Conditions	Browsed under light grazing	Browsed under Med. grazing	Browsed only under heavy grazing	Rarely browsed even under very heavy grazing
y.poplar	black ash	beech	hawthorne	red gum
wh.ash	red ash	black gum	post oak	red cedar*
sug.maple	river birch	bl.locust	shagbark hickory	ironwood
basswood	box elder	chestnut	bl. walnut	bluebeech
slippery elm	hackberry	butternut	Va. pine	pawpaw
mulberry	American elm	sassafras	shortleaf pine	persimmon
sycamore (sprouts)	mockernut hick.(sprts.)	bl.oak	bl.cherry	willow oak
	shagbark " "	winged elm	bl.jack oak	pin oak
	bitternut " "	bitternut hickory	dogwood	bald cypress
	pignut " "	pignut hickory	tupelo gum	
	shellbark " "	shellbark hickory		
	chestnut sprouts	scarlet oak		
	black maple	sycamore		
	burr oak sprouts	honey locust		
	bl.walnut "	chestnut oak		
	red maple	Ky. coffeetree		
	white oak			
	red oak			
	southern red oak			

* Cattle in the Nashville Basin eat the tender, current years reproduction to the extent that it is being eliminated from heavily grazed areas.

A number of other compilations and analysis are being made from the data at hand and it is believed that there is sufficient information on the Oak Hickory type to answer such specific problems as:

1. The extent to which grazing is preventing the normal regeneration of the farmwoods in this type.

2. The relative resistance of tree species to grazing injury.

3. The influence of grazing upon growth and development of tree species through the reproductive stage.

4. The effect of grazing upon the composition of the stand.

5. The effect of grazing upon the secondary vegetation of the woodlot, the relative abundance of palatable and unpalatable species and the number of species present.

Considerable more work remains to be done in the Beech Maple type to secure data comparable to that secured for the Oak Hickory type. The extent of grazing in the swamp types is not of sufficient importance in the Central States region to justify a separate study. Similarly the other types represented are either very little grazed or of such limited distribution as to be of relatively little importance.

Important aspects of the problem

The determination of the phases of the problem which should receive further intensive study was one of the principal objectives of the survey. As a result of the examination of conditions in all of the sections of the Central States, it has been possible to formulate a rather definite conception of the entire problem.

The grazing of domestic animals in the farmwoods throughout the better agricultural districts of the Central States has precipitated two important problems; one economical, and the other silvicultural. If the farmwoods is to take its proper place as a part of any well managed farm it should be handled in exactly the same manner as the rest of the acreage. It must be managed so as to show a return in financial profit, or in raw material for the farmer's own use, which will justify the cost in taxes, time and labor expended in its maintenance. A clear conception of the relation of the primary crop, the timber, to the secondary crop, the forage, etc., and vice versa is necessary as a basis for such management.

Progress in bringing the farmer to realize the potential economic value of his farmwoods has made material progress in the last few years. An ever increasing number of them are seriously considering the future of their woodlands, and the possibilities of forestry on the increasing amount of marginal and submarginal lands. The progressive farmers are rapidly adopting accurate cost accounting systems and are beginning to balance crop by crop and acre by acre. In considering the future management of his woodlands he will be confronted immediately by two questions. First, is the woodlot in its present condition worth maintaining and improving for the primary purpose of producing forest products? Second, if so, what plan of management shall be followed to bring it to its highest productiveness? In answering both of these questions the problem of the economic value of the forage crop will have to be carefully weighed and balanced against the possible reduction in the productivity of the primary crop, timber. This appraisal is needed in the first place to decide whether the woodland shall be permitted to revert to open pastureland, and in the second case to determine, in each individual woodlot, the extent to which grazing will or will not be permitted. Quantitative data will be needed to base such decisions upon and the securing of this information constitutes the economic phase of the problem.

Obviously, however, much of the economic data cannot be properly interpreted without the basic growth and yield figures resulting from the study of the silvicultural phases. It seems reasonable, therefore, that further study should naturally proceed through the silvicultural phases to the economic and it is recommended, that the logical steps to be followed in the future development of this project should be:

1. Empirical study of the beech maple type in Ohio and Indiana for the purpose of gathering data comparable to the information secured by the reconnaissance study for the oak hickory type.

2. The examination of the classified woodlots of Indiana, for the purpose of studying the recovery of grazed woodlands following the exclusion of stock.

3. Assembling the data from the two preceding steps, and that secured from the reconnaissance survey, into a Farmer Bulletin or Miscellaneous Circular, covering the effect of grazing on the reproduction in the farmwoods of the Central States.

4. The study of the effect of grazing on the growth and yield of the woodlot beyond the reproduction stage. This will involve the establishment of permanent sample plots and their periodic remeasurement.

5. The study of possible methods of livestock management on the farmwoods which will prove compatable with the primary purpose of the production of timber. This also will involve intensive study on permanent sample plots.

6. An intensive study of the economic phases of the problem to secure adequate data for the purpose of appraising the relative returns to be expected from grazing and timber production in the woodlots.

7. The assembling of the data available from the study of the preceding phases into a Departmental Bulletin on the "Relation of Grazing to the Farm Woods in the Central States."

Working centers for the grazing project

The reconnaissance survey clearly demonstrated that the grazing situation in the farmwoods of the Central States is unquestionably most acute in the glaciated sections. Judging from Table III the pastured woods of the Wisconsin and Illinoian Drift Areas are carrying nearly twice as many head of stock as the Central Basin of Tennessee which is rated third in this table.

It is recommended that future work on the project be confined chiefly to these glaciated sections and particularly to the Corn Belt. If the farmwoods of this rich agricultural belt are to be saved from the same fate as those of the Blue Grass, present grazing practices must be materially altered. The subjugation of grazing to its proper place in relation to the farm woodland will do more immediate good in the Corn Belt than in any other section of the Central States.

A number of areas suitable as working centers have been examined and tentative offers of land for permanent sample plots have been received from Indiana and Ohio. Types are comparatively uniform over such large areas of the Corn Belt that it will be unnecessary to establish a large number of working centers. Conditions common to the entire Corn Belt can be found in Ohio, Indiana and Illinois.

TS-12 Oak Study

At the close of the 1927 field season the available stands of even-aged second growth, 75% or more oak had been measured. Revision of plans for the 1928 field season provided for collection of yield plots in all available even-aged stands containing 30% or more of oak. This was accomplished that year. One new plot was collected in 1929.

During 1929 an extended search was made to locate cuttings which would permit construction of volume tables for all important species associated with the oaks. The only cutting found was in pitch pine. These measurements were taken in Virginia by I. H. Sims of the Appalachian Station.

During the last part of 1929 a study of the relation of height to diameter in even-aged stands was begun to permit application of volume tables to the tally record on the yield plots. This study resulted in a better understanding of the relation of height to diameter in these stands since the dominant crown cover was found to have a comparatively uniform height while the trees in subordinate positions show a more pronounced variation of height with diameter.

During the year all plot data were transferred to compilation sheets and with the completion of the height-diameter study the volume yield of sample plots can now be computed as far as volume tables are available. The time of completion of this work will depend upon how exacting the requirement is for volume tables for the unimportant associated species.

Chestnut_oak regeneration

An unusual opportunity was presented during the year to study the influence of depth of litter on germination and survival of chestnut oak. The study has two distinct phases; first, investigation of the factors affecting the germination and first season survival of seedlings and second, investigation of those factors affecting the later development of the young stand.

Work on the first phase of the problem began in June, 1929. Some 60 half milacre quadrats were established in areas suitable for study. Twelve of the quadrats were marked permanently and retained for subsequent observation. The detailed examinations and measurements made on these 60 quadrats indicate the great importance of forest litter in the successful establishment of chestnut oak seedlings.

It was found that where the leaf litter covering the acorns was one inch or over in depth the germination per cent was highest and remained fairly constant regardless of increase in litter depth. However a covering under one inch in depth resulted in a greatly decreased germination which was directly proportional to the litter depth.

The effect of leaf litter on early survival was somewhat different, the depth showing most favorable survival being between 1-2 inches. Above and below this depth the percentage of acorns establishing green seedlings fell off markedly.

Examination of nearly 6000 acorns showed approximately 40% infected with nut weevils. However, the presence of weevils does not always result in failure to produce seedlings. The nut weevils were found to be the most important biotic factor interfering with germination and early survival.

An article outlining the results of the study is being prepared for publication.

The second phase of these investigations was commenced in October, 1929 at the Clark County State Forest, Indiana, where opportunities for permanent plot work were available. Three one fourth acre plots were established in second growth chestnut oak. One plot was clear cut, one partially cut and the third reserved as a check. Fifty permanent milacre quadrats were established in the one year old seedling understory of each plot. Seedling counts and height measurements will be made before and after each growing season in order to observe the effect of the several degrees of cutting upon the growth and mortality of the seedling stand.

The next step in the study of yield of second growth oak stands.

Yield of well stocked, even-aged stands of oak at different ages and on different sites is but the first step in a much more involved study. Very few stands are entirely even-aged or well stocked. Most of the stands which have resulted from clear cutting have been cut since for ties, leaving understocked stands which will require a period of years to restore them to a well stocked condition. This calls for study of stocking to permit application of yield tables to such stands.

A further problem is presented by those young stands which have followed heavy cutting. This is the common type which occupies many thousand acres. Such stands are not even-aged and are not usually well stocked.

The study of yield in these two types of forest will require remeasurement of numbered trees through several decades, with due consideration of age and site. The plan must be carefully worked out in advance of general establishment of such plots.

With this purpose in mind an area was selected on the Clark County State Forest in Indiana. This area, known as the 1928 mill tract contains 169 acres. During the winter of 1928-29 an improvement cutting had been made under direction of the Indiana State Forester. In beginning the study of growth on this area the experiment station party first prepared a topographic map using 5 foot contour intervals. Strips one chain wide and ten chains apart were marked out across the tract. These cover approximately 10 per cent of the entire area. On these strips numbered tags were placed on all trees of the three inch class and larger. A record of these trees was commenced and will be completed in the spring of 1930. For each tree the tree number, species, D.B.H. and crown class were recorded. The tally was kept separately for each square chain of strip. Enough heights will be obtained for satisfactory height curves of each species. Records of new and old stumps within the plot and also within 25 feet of either side were also kept. A certain amount of age data from increment borings and ring counts on stumps will also be obtained in the spring of 1930.

Remeasurements at five year periods are recommended for this work and computation of the first series of measurements will indicate the classification of data needed and will guide subsequent work.

Mc-1 Management-Cutting

This project was set up in the program for the current year to permit investigation of methods favorable to white oak regeneration on the Ozark National Forest.

A field party under leadership of L.I. Barrett examined the Bear Pen sale area on the Sylamore ranger district of this Forest. Twenty-three forties were examined by the line plot method. All trees including reproduction were tallied on five plots per "forty." Areas cut and those not cut-over in the 1929 logging operation were examined.

In spite of a good seed crop of white oak the preceding fall very few white oak seedlings were found. The problem of successful establishment of seedlings of this species still remains, but a very heavy sprout regeneration from older rootstocks burned back in a series of fires, is general over the sale area. Reproduction up to two and one half inches in diameter averaged about 3000 stems per acre. White oak is very prevalent in this stand. Sprout reproduction covers the ground so effectively and grows so rapidly that young white oak seedlings could not survive even if established. Fire protection alone will bring about an adequate young growth of hardwoods whose only defect is the decay found in some of the wounded rootstocks. One-third of the three important oaks is defective. This cannot be corrected until the young forest attains a size which will justify removal of defective trees. Since this forest condition is complicated by remoteness from market and a fire hazard not yet controlled, there is no reason for immediate study of the problem of white oak reproduction by seed on this ranger district of the Ozark National Forest.

T-1 Forest Types

This study was carried on incidental to other work of the Station except for one trip into Kentucky and Tennessee made by Gordon. Observations of specific type occurrences were made by several members of the staff in following out general instructions for this project.

During this year a national committee of members of the Society of American Foresters was appointed to draft a type classification for all forests of the United States. McCarthy as representative of the Central States region on this committee, asked the support of the Ohio Valley Section which voted to select a committee to assist in drafting the classification. This action increases the urgency of this study in order to avoid acceptance of an unworkable classification for the Central States region.

Two difficulties in preparing a type classification must be met. (1) The purpose it is to serve varies among agencies interested in its creation. (2) The decision regarding the size of area which will be recognized as a type will determine the number of types finally selected and described. Preparation of a report on types is therefore more a matter of agreement than of information.

Erosion

Following the recommendation of the Research Council, a survey of the region was made to determine the extent and character of erosion of agricultural land and the feasibility of starting erosion control studies.

Agencies familiar with conditions in each state were consulted and field examinations were made in accordance with this advice. Only a brief statement of the results of the reconnaissance is included in this report since a special report will be prepared in addition. In all states there is recognition of the need for forest planting on eroding land, but in most of the states the problem is considered to be economic rather than silvicultural.

Examples of erosion found in this investigation can be grouped into four classes.

1. Erosion on steep topography. Many thousands of acres of forest lands have been cleared and farmed on slopes so steep that the surface soil started immediately to wash away. These fields are now being abandoned for economic reasons and rapid reforestation is desirable. The problem is the general one of getting the species of tree best suited to the soil conditions left by erosion, and its successful and cheap establishment. Mechanical control of gullies will be minor in this type of land which is found chiefly in unglaciated, hilly sections where there has been no deposit of soil by wind.

2. Erosion in limestone sink holes. The margins of sink hole depressions are eroding severely but these depressions are often found in otherwise good fields. This problem is largely one for treatment by mechanical methods, improved agricultural practice or pasturage. In some instances sink holes can be used to grow post timber and other materials for farm use. When sink hole erosion is serious enough to cause abandonment of land, forest planting is logical. Sink hole erosion is confined to the rims of the depressions and gullying is usually not deep. Various species will be needed to suit the differences in moisture conditions of the soil. This is a field for study of suitable mixtures of species and for the establishment of demonstrations of effective use of sink holes through forest planting. In some instances sink holes occur in rough topography which further emphasizes the need for restoration of the forest.

3. Deep gullying in stream bluffs. Streams that have recently cut deep channels in glacial deposits have commonly created bluffs too steep for cultivation. The native forest growth along these bluffs served to check the erosion from the face of bluff and to prevent the deepening of gullies which are headed back in good agricultural upland. The present menace is the natural consequence of the fast cutting of such large streams as the Wabash river, and the steepness of lateral gullies. Clearing and cultivation of land at the head of these gullies furnished a good volume of water which continued the natural process of cutting. Clearing along the bluff and ravines allowed the channels to deepen toward the base level of the river.

Since trees can correct this erosion only at the source, two steps are feasible. The face of the bluffs can be reforested to prevent new gully formation and trees will be effective if planted about the heads of gullies. The latter step will force planting on land which is still of good agricultural value. The more logical program lies in mechanical control of water entering the heads of the gullies. This is plainly an agricultural problem.

4. Loess and fine silt soils. Some farm land with loose soils erode even on gently rolling topography. Wind blown soils (called loess) and other fine silt soils which contain small amounts of rock fragments are subject to this type of erosion. Such land if carefully cultivated can be kept free from erosion, but once the surface soil is gone and deep gullies are formed, forest planting offers the most feasible method of reclamation.

The worst erosion in the Central States region is found in the unconsolidated soils of western Tennessee. Control by locust planting has been demonstrated in this section by the Tennessee State Forestry Service and work on similar types of soil is being carried on by the Southern Forest Experiment Station in Northern Mississippi.

This review of erosion conditions is presented to show the need for extensive forest planting on lands already severely eroded and upon lands which are beginning to erode. This is chiefly part of a general problem of reclamation of idle land through forestation which requires experimental work to determine the best planting practice and most desirable species.

M-1 Private Forestry

This project is part of one national in scope and has been set up to permit the organization of data which comes to the attention of the Station. During the year records of forest property over 1000 acres in extent which are definitely under management have been furnished to a committee of the Society of American Foresters. This is being combined into a report on Commercial Forestry. Activity of this kind is limited to few areas outside those publicly owned in this region. Active planting and other work tending to the improvement of forest conditions is progressing fastest on areas smaller than 1000 acres. Records of all plantations using state nursery stock are of course furnished on the application blank filed in state forest offices.

PROGRAM FOR 1930

Fp-1 Plantation Study

This project has been in progress for two years. It was originally initiated in 1928 and at that time it was estimated that the project would be finished in two years. After the first year's work, it was evident that the project could not be finished in the allotted time and the date of completion was extended tentatively to 1931. After two year's work on this project it is very evident that it may extend for a longer period of time in order to make it complete and to thoroughly canvass and inspect the plantations of all forest species within the Central States territory. In 1928 one field party of two men was engaged and in 1929 two parties were in the field. One of these was engaged in climbing work so that there was only one effective party to inspect and measure older plantations.

There are several reasons why this project has not been completed in the stipulated time. In the first place, it is a far larger task than was anticipated at the time the project was started. This became evident at the end of the first season and has resulted in an extension of time. There are far more plantations than are recorded in the files of forest schools, state agencies, and the Forest Service. In order to give these unrecorded plantings their share of attention, travel schedules and estimates in amount of work to be accomplished necessarily fall far behind. In the second place, there are inadequate funds available for this project to put sufficient parties into the field to cover the ground within a relatively short period. The chief of party can efficiently handle the supervision of more crews than can be placed in the field under present resources. A maximum of two crews have been used to date and several more could easily be used to great advantage. If field parties can average one plot a day, their performance is highly satisfactory. As a rule a much lower average is to be expected because of the interferences of travel, inclement weather, the making of inquiries, the hunting out of references and the delays of being in unfamiliar territory. In districts where plantings are infrequent, a lower average is secured than in one where plantings are fairly common. In the third place, temporary employees are available for a relatively short period of time. Three months is the usual period of employment, after which they return to school. A portion of this time is necessarily used in becoming familiar with the character of work and the routine of taking the data. During this period, the men are less efficient than at the time of their departure. Finally, the expanse of country over which the field parties must work is extensive. Plantings are scattered over the countryside and access to them is secured only by large amounts of travel, which cuts down the effective time and effort available to inspect and measure them.

Plans for 1930

During the field season it is planned to continue the inspection and measurement of plots in plantations. No climbing work will be done during the year, To date, of the total of 166 plots taken, 96 are black walnut. This results in a scattering of plots through the many species and mixtures which are encountered in the remaining 70 plots.

It is planned to concentrate effort very strongly on black walnut. As a result of a reconnaissance of Iowa during 1929 for the purpose of sampling walnut stands in that state for volume table purposes, information is at hand regarding stands suitable for walnut yield plots. It is planned to use one crew to measure these plantings. Measurement work will continue simultaneously on the plantations in Illinois. In view of the wide variation in spacing and therefore stocking which is found in various groves, as well as the elimination of plots from cutting and other reasons, it is felt that at least 175 to 200 plots of black walnut are needed and are easily available. In natural, fully stocked, even-aged stands 100 - 300 plots are necessary, It is further desired to secure data on sprouting of black walnut and to take measurements on the sapwood-heartwood content of trees below 12 inches DBH for this species. Two 2-men crews will be used to carry on this work.

As time becomes available the volume tables for plantation-grown black walnut will be constructed from the measurements taken in 1929. The tree-graphs are now being checked for errors in plotting and curves are being fitted to the points, preparatory to planimetering the graphs for cubic content, and scaling them for board foot content. Effort will be made to secure data on the sap-heart content of trees below 12 inches breast high, before those measurements at hand are worked up.

Pa-1 Grazing in relation to the farmwoods

The completion of the reconnaissance survey makes possible the continuation of the project along the specific leads recommended in the annual report. The work for the coming field season will be confined to Ohio and Indiana and semi-permanent plots will be located and measured for the purpose of rounding out the data collected during the past two years on the effects of grazing on the reproduction in the farmwoods. A number of areas possibly suitable for study of the more intensive phases of the project will be examined and if satisfactory arrangements can be made, permanent sample plots will be established.

Tentative plans for the conduct of the work this year provide for one crew of two men, for the period of June 16 to September 15. A second crew of two men will be transferred from the plantation study approximately August 1 and will continue with the grazing project until about September 15. Both crews will be under the direction of Ralph K. Day and the work will be so planned that he can give a maximum of supervision to each crew.

The specific objectives to be accomplished during the field season of 1930 are:

1. Location and measurement of a minimum of twenty-five grazed and twenty-five ungrazed semi-permanent plots in the beech maple type in Ohio and Indiana, These plots to be confined to stands having less than 90 per cent crown density.

2. The location and measurement of a minimum of fifty semi-permanent plots in the classified woodlands of Indiana for the purpose of studying the recovery of grazing following the exclusion of stock. These plots to be as equally distributed over the oak hickory and beech maple type as possible.

3. The location and establishment of permanent sample plots for the purpose of studying the effect of grazing on the growth and yield of the stand beyond the reproductive stage and also for the purpose of determining possible methods of livestock management compatable with the production of timber. These permanent sample plots will be established as rapidly as suitable arrangements for their control can be made.

4. The collection, as opportunity affords, of all information bearing on the economics of the problem.

5. The collection of photographs suitable for illustrating publications, showing the specific damage caused by grazing animals on - the reproduction, the mature timber, the vegetative cover, the litter and humus, and the soil.

Following the field season the information secured on objectives (1) and (2) will be compiled and analyzed, and a report prepared for publication containing these data together with the findings of the reconnaissance survey. This publication to cover the effect of grazing on the reproduction in the farmwoods of the Central States. This publication will probably be a Farmers Bulletin or a Miscellaneous Circular of the Department of Agriculture.

TS-12 Oak Yield Study

Two phases of this study are carried over into the current year.

1. Compilation of volume tables.

2. Computation of yield data by use of these tables.

Field work was planned for 1929 with the purpose of securing further measurements of subordinate species such as black gum and black locust for volume tables. The opportunity was not found in 1929 except for pitch pine.

During 1930 such an opportunity will be sought again with the recommendation that existing volume tables be used in the fall of 1930 if suitable measurements are not available for new tables.

The computation of yield tables will continue through the winter of 1930-31.

The next step in the study of yield of even-aged stands will be the application of these tables to understocked even-aged stands of oak. Field work on this phase of the study can be carried through the stage of locating suitable areas but the establishment of permanent plots must await construction of the yield tables.

The study of all-aged stands may be considered a phase of the oak study so long as it is limited to the forests of drier sites since oak constitutes a major part of such stands. A test plot has been set up on the Clark County State Forest of Indiana to work out methods for an extensive study of growth in all-aged stands. Data secured here will be correlated with the first and second phases of the oak yield study.

Those plots established to study development of chestnut oak seedlings will be measured annually through a period of years.

MC-1 Management Cutting

The examination of a sale area on the Ozark National Forest led to evidence of adequate potential sprout reproduction. This does not solve the problem of restoring seedling stands to this or similar areas but it does indicate the need for observations through a period of years on permanently controlled areas. The study of white oak regeneration as controlled by cutting is but a small part of the problem of forest regeneration in this region. As areas are selected for working centers, plots will be established for close observation, and treated to study the effect on seedling establishment.

Since changes in forest soil and litter conditions as well as temperature and humidity are the primary reasons for success or failure of seed germination and establishment of seedlings, studies of litter and soil will be carried on in conjunction with cutting experiments.

M-1 The fundamental study of litter as a factor in forest management.

Importance - Those who have made a study of conditions affecting the life history of the forest have recognized in a general way the importance of litter, not only in the growth and regeneration of the forest, but as a factor in the control of type succession. Litter is the principal medium in which the plant food elements, taken from the soil by the growing forest crop is stored and subsequently released again to supply the food elements needed by successive forest crops. The character and depth of the litter and consequently the rate at which plant foods are released to the growing crop are partly within the control of human agency since by varying the density of the crown cover the rates of accumulation and decomposition of the litter can be controlled. In addition to this there has long been recognized the value of litter as a mulch which exerted an influence on the physical and chemical character of soils beneath the litter. Under virgin forest conditions undisturbed by man, fire, or animal agencies introduced by man, and with adequate drainage, forest litter eventually reached a depth at which the rate of decay balanced the accumulation. Interference by any of the agencies mentioned above, especially cutting and fire, quickly upset this balance and created a site condition unfavorable to the mature trees previously established. The creation of stag-headed old trees resulting from this upset of the litter balance has long been recognized. Nearly every farmer has seen apparently healthy trees in his woodlot die as a result of destruction of leaf litter. Even among those who have made the greatest study of forest growth conditions, exact information concerning the influences of forest litter does not exist.

Relation to other studies - Scarcely any project undertaken by the Station in its effort to determine the best methods of management of the forest can be carried to completion without including in it detailed work on the influence of litter as a controlling factor. Two projects now current in the Station program are used to illustrate this point.

The study of older plantations is an attempt to determine the success which has been secured by the planting of a large number of tree species, some of which are native and some exotic. These plantations have been established on a variety of soils and under a variety of topographic conditions. In practically all instances, however, they have been planted on soils subject to cultivation or at least to pasturage since the destruction of the original forest cover. In some instances they have been planted on prairie land which had no original forest cover. Under practically all circumstances these plantations have been forced to compete with weed and grass vegetation and are so small in area and wind-swept that litter did not accumulate underneath them. True forest conditions usually have not been established. Contrasted with this, other plantations have been made in land previously cleared but neither pastured nor cultivated. Such plantations have the benefit of the loose soil conditions created by the forest combined with some litter which has drifted in from adjoining woodlands. The benefit of these conditions is immediately apparent over that of similarly located land which had been subject to cultivation. The entire story of success and failure in the test of various species on the various types of soil cannot be completely written until the tests have been continued under adequate forest soil conditions.

In some instances land which had once supported a crop of hardwoods and was subsequently cultivated for agricultural crops has so changed in soil character that the original species cannot be immediately reestablished. This may involve more than the loss of litter but it probably can be explained by contrasting the conditions of soil under forest cover with similar soil in open fields under cultivation.

The study of the influence of grazing on the farm woods has already brought into prominence the question of litter deficiencies in these stands of small acreage. The browsing of cattle removes the understory of shrub vegetation which would retain leaf litter on the floor of the forest. The wind, given an unchecked sweeep through small areas of timberland, may remove nearly the entire leaf crop, blowing it against the fences and into adjoining fields.

Method - An immediate attack upon the problem presented by each one of the Station projects would result in much ill-directed effort since a fundamental understanding of the character of litter, its influence upon the soil, its quantative amounts, its annual rate of accumulation and decomposition are entirely lacking. These are factors which will vary with the size of the timber area, the types of forest, the climate, and the history of the forest.

A fundamental approach to the subject of litter is the only logical one, with such correlations with the other current projects of the Station as can be fitted into the study as it progresses. The plan of attack, therefore, proposes beginning the study by an examination of litter conditions in undisturbed tracts of timber as nearly virgin as can be found representative of the important forest types and extending over the full range of climatic conditions found within the Station territory. Although this sounds like a very inclusive program, the Station now recognizes that there will be difficulty in finding many such areas. These areas will serve, however, as standards where litter can be studied in relation with the underlying soil types which in turn can be correlated with the existing data on similar soils found in cultivated areas. On this phase of the subject there will be no repetition of work already done by the numerous agencies which have studied soils from the view-point of the agriculturist.

When an adequate understanding is had of the character of soils under virgin forest conditions it will then be possible to determine what deteriorating or beneficial influences have resulted from interferences by cutting, fire, grazing and cultivation.

Briefly stated the general object of the litter study of well stocked virgin stands is to secure a record of the conditions of litter and soils under virgin forest. This data will serve as a basis for the further study of fire, grazing and erosion injuries. Physical, chemical, and microbiological conditions of soil under virgin state were presumably optimum for growth of the particular forest type involved; consequently a general study of virgin conditions will lay the foundation for comparative research on forest conditions applying in artificial conditions.

Specifically, the immediate objects will be as follows:

1. To determine the amounts of litter produced per acre by different forest types.

2. To determine the extent of the accumulation of organic matter under stands of respective types.

3. To study the distribution of humus in the soil profile.

4. To learn the changes in the distribution of the different texture fractions due to litter cover and lack of it.

5. To determine the accumulation of Calcium in the A_0 or litter horizon.

6. To study the base exchange capacities of soils as influenced by litter.

7. To study the effect of litter on soil reaction.

8. To ascertain the effect of the solvent action of decomposing litter on the mineral components of soil.

9. To determine to what extent litter changes porosity and consequent water-holding capacities of soils.

10. To gather data as a basis of comparison in the study of fire and grazing damage.

11. To preserve for future reference an exact picture of soil conditions under virgin forest.

Assignment - This work will be assigned to one man (J.T. Auten) in the Station assisted by a very limited field party and by such cooperative assistance as can be secured from outside agencies.

Cooperation - This subject is so broad and has such an important bearing on the management of existing forests and especially upon the establishment of plantations that many outside agencies may wish to undertake some phase of the problem. One graduate student of Ohio State University has already undertaken a problem of plant nutrition looking to the nitrogen requirements of forest trees. Other graduate schools in the region may wish to undertake other phases in which case the Station will be willing to assist in an advisory capacity and serve as a medium for the correlation of such studies. The fullest extent of cooperation in this project, while desired by the Station, may require several years for development.

Reports and Articles - 1929

In Print

McCarthy, E.F.	Forest Problems in the Hardwoods. Proceedings 10th Southern Forestry Congress.	✓ 28
	Forest Cover as a Factor in Flood Control. Paper No. 1709 - Transactions. American Society of Civil Engineers.	✓
	Yellow Poplar Leaflet. American Woods. Forest Service, U.S.D.A.	✓
McCarthy, E.F. and staff	Part II. Forest Conditions within the Ohio River Watershed. Relation of Forestry to the control of floods within the Mississippi Valley. Document 573. House of Representatives.	✓
Day, Ralph K.	Forests Follow the Charcoal Burner. Empire Forester, 1929.	✓

Not in Print

Barrett, L.I.	Four Volume Tables for Second Growth Yellow Poplar.
	Possibilities of Fire Extinguishing Chemicals in Fighting Forest Fires.
	Accelerated Growth of Longleaf Pine.
Day, Ralph K.	Speeding our Departing Guests. For Nature Magazine.
Kellogg, L.F.	The Measurement of Yield in Forest Plantations.

Project (Fp-1)

Study of older forest plantations in the Central States region.

Objects

To determine from a study of existing older plantations:

1. The suitability of those species already tried for planting in the region.

2. The conditions of soil, soil moisture, climate, spacing, and treatment, which have resulted in successful plantations for each species.

3. The economic success of plantations as measured by yield of the stands.

4. The need for further tests of species and experiment in phases of planting not yet covered.

5. The best method of measuring plantations for use in future studies to be made in this region.

Status

This project was started in 1928 and has been actively carried on for two years. The working plan has been revised and approved, and field work has been finished in Kentucky, Indiana (excepting the State Forest) and portions of Illinois. Data have been assembled for the construction of volume tables for planted black walnut as well as for studies on form, bark thickness, sap and heartwood content and sprouting of this species.

Plans for current year

Further review of published work.

Secure additional sap-heart measurements on black walnut for diameters under 12 inches, as opportunity is offered.

Carry on field examination and plot measurement in plantations in Illinois and Iowa. Two field crews will be used. Emphasis will be laid on black walnut and Iowa will be covered to pick out these stands before others are taken, in order to complete the data for this species.

Cooperation

Good cooperation has been received. All forestry organizations and agencies which have been asked to assist have made very material contribution to this project. The fullest mutual assistance possible is desired.

Date of Completion (for Walnut phase)

Tentatively set at spring of 1931 or 32.

Assignment

L. F. Kellogg

Character of publication

Technical bulletin. Separate publication on individual species which justify it, such as black walnut.

Project (Pa-1)

Study of the relation of grazing to farmwoods.

Purpose

Continuation of the study along the specific leads recommended in the Annual Reportfor 1929.

Status

Reconnaissance survey for the purpose of defining the problem completed. Sufficient data in oak hickory type secured to determine effect of grazing on the reproduction.

Specific objectives to be accomplished during 1930

1. Study of understocked stands of beech maple in Ohio and Indiana to round out data in this type.

2. Examination of classified woodlands of Indiana for the purpose of studying recovery of grazed woodlands following the exclusion of stock.

3. Examination of areas suitable for permanent sample plot work and establishment of these plots as rapidly as satisfactory arrangements for their control can be made. Permanent plots to be established for the purpose of studying the effect of grazing on the stand beyond the reproduction stage and also for the purpose of determing possible methods of livestock management compatable with the production of timber.

4. The collection as opportunity affords, of information bearing on the economics of the problem.

5. Following the field season the information secured on objectives (1) and (2) will be compiled and a report prepared for publication containing these data together with the findings of the reconnaissance survey.

Cooperation

The State Foresters of Indiana, Kentucky, Tennessee and Ohio have expressed their willingness to cooperate in the more intensive phases of this study. Antioch College at Yellow Springs, Ohio has offered an area which has possibilities for permanent sample plot work. Direct cooperation has been arranged with Purdue University.

Date of Completion

Indefinite. Publication of data secured by reconnaissance survey and current year's work set for spring of 1931.

Form of Publication

Farmers Bulletin or Miscellaneous Circular of the Department of Agriculture, covering the "Effect of Grazing on the Reproduction in the Farmwoods of the Central States."

Eventually the various phases of the study will be combined into a departmental technical bulletin on the "Relation of Grazing to the Farmwoods of the Central States."

Assignment

Ralph K. Day

Project (Pf(c-1))

Test of chemical fire extinguishing solutions.

Purpose

To test solutions of alkali salts under normal forest fire conditions to determine their efficiency for extinguishing the common types of forest fire.

Status

A series of tests of a solution of alkali salts furnished by the Fyr-Fyter Company of Dayton, Ohio was conducted early in the spring. These tests showed the material to be effective in strong solutions. The cost of the patented material and excessive amounts needed for effective strong solutions make it generally impractical for field and forest fire suppression in this region. The report submitted through the Branch of Research to other Stations resulted in further tests of other alkaline solutions. No further work is contemplated at this Station.

Recommended

That the project be closed.

Project (TS-12)

Yield of second-growth even-aged stands of upland eastern hardwoods containing thirty per cent or more of oak.

Purpose

Continuation of the study of well-stocked, even-aged stands as described, to obtain tables of yield. This also involves construction of volume tables.

Status

Field measurements of yield plots completed. Volume tables available or under construction for all except subordinate species. Black locust and black gum measurements are still needed. Computation is being continued as rapidly as available time permits.

Plans for current year

Continuation of computation of available data.

Finding and measurement of cut trees for additional volume tables.

Cooperation

With Appalachian Forest Experiment Station, Allegheny Forest Experiment Station, state and private agencies.

Date of Completion

1931 for yield table.

Form of Publication

Department bulletin.

Assignment

E. F. McCarthy and L. I. Barrett.

Project (T-1)

Classification of forest types for the Central States region.

Purpose

1. To name and describe the forest types of the region.
2. To bring the various forest agencies into accord as far as possible on a classification of types adequate to their needs.
3. Correlation of the type classification with those of other adjoining regions.

Status

Continuation of the project inaugurated at this station in 1928.

Plans for current year

1. Assembling of collected information into a classification of types in the region.
2. Correlation to classification of this region with others through agency of a committee of Society of American Foresters.

Cooperation

Committee of Ohio Valley Section, Society of American Foresters.

Foresters and other interested agencies in the region.

Completed

During current year.

Form of Publication

As a part of National Committee Report.

Assignment

E. F. McCarthy

Project (M-1)

Study of litter as a factor in forest management.

Purpose

To provide fundamental information regarding the properties and influence of litter so that the effect of changes in forest conditions which result in loss or partial removal of litter may be evaluated.

Status

New project. Begun at this time to answer questions arising out of other studies now on the Station program.

Object

The ultimate object is to provide basic information as to quantity, chemical and physical character, rate of decay and influence on forest growth of litter in the several forest types under different methods of treatment.

The immediate object is to secure a record of litter under virgin conditions of forest and through this information to determine the effect of grazing, fire and rate of site improvement under planted stands.

Work on this project will be correlated with studies Pa-1 and Pf-1.

Cooperation

An attempt will be made to secure the cooperation of other research agencies in the region. Phases of the study may be separately undertaken.

Date of Completion

A continuing project, phases to be consecutively undertaken and reported.

Form of Publication

Early phases of the work to be prepared as short articles. Sections of other studies such as Pa-1 and Fp-1 to contain material secured through this study. Final publication a department bulletin.

Assignment

J. T. Auten